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UNITED STATES JAPAN EXPEDITION.

OBSERVATIONS

ON

THE ZODIACAL LIGHT,

FROM

APRIL 2, 1853, TO APRIL 22, 1855,

MADE CHIEFLY ON BOARD

THE UNITED STATES STEAM-FRIGATE MISSISSIPPI,

DURING HER LATE CRUISE IN EASTERN SEAS, AND HER VOYAGE HOMEWARD:

WITH

CONCLUSIONS FROM THE DATA THUS OBTAINED;

BY

REV. GEORGE JONES, A. M.,

CHAPLAIN UNITED STATES NAVY.

"Je ne comprends pas par quel sort un objet [la Lumière Zodiacale], qui touche de si près l'astronomie moderne et la physique céleste, a été négligé jusqu'à ce point par les astronomes et par les auteurs météorologiques."—MAIRAN.

VOLUME III.

WASHINGTON:
BEVERLEY TUCKER, SENATE PRINTER.
1856.

IN SENATE OF THE UNITED STATES,

January 22, 1855.

Ordered to be printed, and that 5,000 additional copies be printed; five hundred of which for the use of Commodore Perry.

January 29, 1855.

Ordered, that 500 copies be for the use of the Navy Department.

INTRODUCTION.

APPEARANCE OF THE ZODIACAL LIGHT.

To PERSONS not familiar with the subject of this work, it may be proper to state, that, what is called the Zodiacal Light, is a brightness which appears in the western sky after sunset, and before sunrise in the east, following nearly or quite the line of the ecliptic in the heavens, and stretching upwards to various elevations, according to the seasons of the year. It has been called by this name, from the fact that it was formerly thought to confine itself within the limits of the zodiac. It appears to best advantage when the ecliptic makes its highest angle with the spectator's horizon; at which times, in moderate latitudes, it reaches to his zenith or beyond it, having near the horizon a striking brilliancy, and thence fading upward, mostly by imperceptible degrees, till, at its vertex, it can be made out only by a careful and experienced eye. As those seasons advance when the ecliptic is declining gradually towards the horizon, the Zodiacal Light fades away, till it is perhaps entirely lost, or can be seen only by those who have followed it, in its changes, night after night, and are thus able, by familiar acquaintance, to detect and trace its dim markings on the sky.

In our high northern latitudes, it can be seen with difficulty, or at least can be made out unsatisfactorily, through a large portion of the year; while at the European observatories, most of them still further north, it is generally very obscure; and observers in these countries have, therefore, been discouraged from attention to a subject for which their circumstances are so little favorable. In the lower latitudes, however, and especially in those near the equator, it has often an exceeding brilliancy at the horizon, ascending from this, a striking object, far into the sky; and I have in several instances known the *reveillé* to be beaten in our ships, evidently from mistaking the Zodiacal Light for the dawn. I remember, on one occasion, when in the "Mississippi" during her late cruise, we had sighted the light-house of Point du Galle, in Ceylon, in the evening, and the ship was ordered to be kept lying off till the morning would permit us to enter the harbor, word was passed for the "officer of the deck to send for the captain and first lieutenant at early dawn." I was on deck in the morning at my observations, a few minutes after four o'clock, when the lieutenant on duty came up to me and said: "Don't you call this early day-light?" I answered "No, it is not day-light yet." "Why," he said, "what do you call this over here?" pointing to the Zodiacal Light, which was showing itself with an effulgence that might very easily lead to such a mistake; though it wanted yet more than half an hour of the earliest dawn. See also the close of my record No. 111, where it is noted that, at two hours after sun-set, I overheard one of the quartermasters, as he was looking at the Zodiacal Light in the west, remark to another: "If that was not in the wrong part of the sky, I should say that the sun was just going to rise there!" Humboldt, in

Cosmos, vol. 1, remarks on this subject: "Those who have lived for many years in the zone of palms, must retain a pleasing impression of the mild radiance with which the Zodiacal Light, shooting pyramidically upwards, illumines a part of the uniform length of tropical nights. I have seen it shine with an intensity of light equal to the Milky Way in Sagittarius; and that, not only in the rare and dry atmosphere of the summits of the Andes, at an elevation of from thirteen to fifteen thousand feet, but even on the boundless grassy plains, the llanos of Venezuela, and on the sea-shore beneath the ever clear sky of Cumana. This phenomenon was often rendered especially beautiful by the passage of light fleecy clouds, which stood out in bold relief from the luminous back-ground."

It may be well to remark here, however, that the Zodiacal Light has a warm, yellowish tint, unlike the cold, white light of the Milky Way.

HISTORY OF OBSERVATIONS PREVIOUS TO THESE.

It seems scarcely probable that a phenomenon, so striking in southern latitudes, could have escaped the attention of early astronomers in those countries; but we meet with nothing in their works of a fully definite and reliable character. We are not to infer, however, from this, that the Zodiacal Light did not exist and shine then, as it does in modern times. Seafaring men have to be ceaseless watchers of the nightly skies; yet it is very seldom that one can be found who has ever noticed this phenomenon as such, unless his attention has been directed to it in a particular manner, or from some particular circumstance. Its most striking aspects are just before the dawn, or just after twilight, at which time it forces itself on the attention, but is in general supposed to be a part of the crepuscule itself. What I have just said about the mistakes in our squadron is to the point; and such facts will also explain the doubts that arose in Cassini's mind, when, in 1683, he first began to notice the Zodiacal Light. He had been previously employed in careful observations of other matters in the same quarter of the heavens, without having at all noticed this phenomenon; whence he half inferred that it now, for the first time, made its appearance in the sky—an inference which subsequent observations and reading led him readily to abandon.

Recurring to our theme of the ancient records, it has been thought that Pliny alludes to it under the name of *trabes*, or the *δοκους* of the Greeks, which Humboldt, however, supposes to refer to another matter.

Festus Pompeius notices something of this character, under the terms Acies and Cyparissæ. Ammonius, in his life of Charlemagne, A. D. 807, mentions an appearance somewhat like that of the Zodiacal Light; but nothing fully reliable can be found till we come to Childrey's Britannia Baconica* published in 1661, in which is a clear statement of his having seen it, together with a brief description of its appearance and shape, occupying, however, but a few lines of his book.

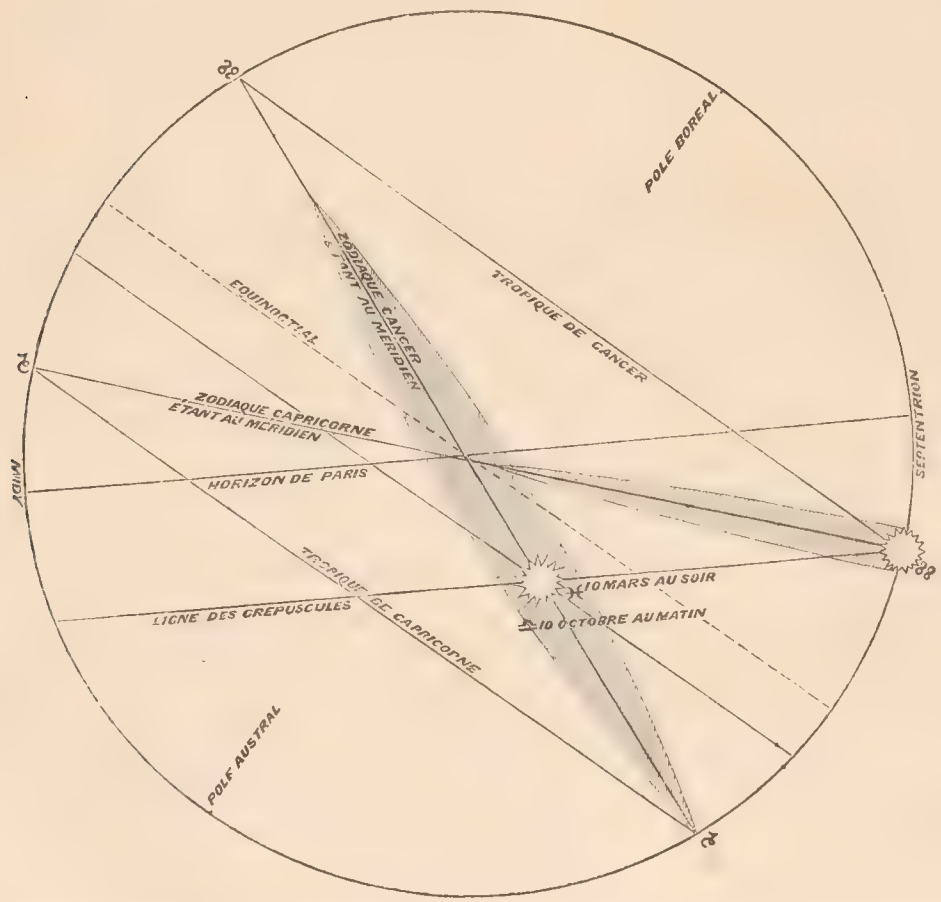
The next observer, and one to whose merit all subsequent writers on this subject have deferred, was Dominicus Cassini, an Italian by birth, but, at the time of his observations, attached to

* "There is another thing which I recommend to the observation of mathematical men, which is: that in February, and for a little before and a little after that month (as I have observed several years together), about six in the evening, when the twilight hath almost deserted the horizon, you shall see a plainly discernible way to the twilight, striking up towards the Pleiades, and seeming almost to touch them. It is so observed any clear night, but it is best *illac nocte*. There is no such way to be observed at any other time of the year (that I can perceive), nor any other way at that time to be perceived darting up elsewhere. And I believe it hath been, and will be constantly visible at that time of the year. But what the cause of it in nature should be, I cannot yet imagine, but leave it to future inquiry.—*Britannia Baconica*, 1661, *p.* 183.

the Royal Observatory at Paris, and doubtless the greatest cosmologist of his day. His first notice of the Zodiacal Light was on the evening of the 18th of March, 1683, when, observing in the west for other things, he was struck with this luminous streak reaching far up in the sky. Unfortunately for subsequent times, Cassini's active mind immediately began to theorize; and he had made but ten observations, when he worked up an hypothesis, which, though formed so rapidly and on such slender and insufficient data, has yet, ever since, warped the judgment of astronomers, and even led to imperfect modes of observing the phenomena of the Zodiacal Light. We have, in this case, an exhibition of the danger of beginning to theorize before we have a sufficient supply of data to work upon.

Cassini discovered very soon that, as time advanced through March and April, the upper or northern edge of this Light inclined more and more off from the ecliptic, and stretched on farther to the northward; and knowing that the sun's equator, as shown by his spots, was also now stretching off from the ecliptic in a similar way, he came to the conclusion that the substance giving this light was closely connected with the sun's equator, and was consequently changing its position with that equator*. He argued further, that, as the sun has an atmo-

Cassini's Diagram.



* "Je fis réflexion que l'équinoxial propre du soleil, qui est connu par le mouvement de ses taches qui se meuvent autour de lui, déclinait alors [March and April] de l'écliptique selon apparence du côté d'orient vers septentrion, et que cette declinaison augmentait de Mars en Avril; ce que me fit penser que le mouvement apparant de cette lumière pourrait être reglé par celui du soleil autour de son axe, et la lumière renvoyée à peu près selon le plan de son équinoxial."—*Mémoires de l'Académie Royale des Sciences, tome* viii, *p.* 127.

sphere, and is, therefore, capable of emitting dense vapors, and, moreover, is continually sending out matter of exceeding fineness, which we call light; consequently, this luminary might also, by its motion on its axis, send out a substance intermediate in character between the two, which substance, either self-luminous, or by reflection, might give us the Zodiacal Light. The diagram which is attached to his article on this subject in the *Mémoires de l'Académie Royale des Sciences,* vol. 8, gives the shape of this body or emanation, as lenticular, with its greatest thickness about twice that of the sun as seen in March, but only of the sun's thickness when seen by us in June; at which latter time, also, it is drawn so as not to reach the horizon of a spectator in the latitude of Paris. Whether he meant to have this lenticular-shaped medium to be considered as attached to the sun, and revolving at the same time with it, or not, is not apparent from his writings. At one time he appeared to think that this matter might consist of an infinite number of small stars, such as are thought to give us the light of the Milky Way, and he made telescopic observations with reference to such an idea; but the results were not satisfactory to his mind. So, also, with scintillations or bright dartings of brief light along the course of the Zodiacal Light, which for a while were thought to be seen; further observations made these doubtful, and the idea of such appearances was laid aside.

I have dwelt so long upon Cassini's observations and theories, inasmuch as these observations, though made one hundred and seventy years ago, exceed in amount all others subsequently printed; and his annotations have a distinctness which I have not been able to find in any other work; besides that his theory has had such an important influence over the minds of astronomers in all subsequent times. He continued his observations, pretty regularly, for six years; and afterwards in a more desultory manner, till 1693; and thus we have eleven years of very important records from his pen. I have, from his detailed descriptions, been able to draw outlines on my star-charts for eleven nights, when his latitudes and my own were sufficiently near for comparison of results; and I find that, in many instances the boundaries of the Zodiacal Light, at his time (one hundred and seventy years ago), were almost, or perhaps quite, the same as at present. It is somewhat difficult to get his boundaries precisely, inasmuch as he describes them by the figures of the pictured constellations; which pictures, we know, are often varied to suit the fancy of the artist dealing with the stars, and are therefore no certain guide. Some of these outlines from his records, drawn out on charts, are appended to this work (Nos. 342–351) for comparison with those of our own times.

Cassini's labors gave a start to other observers, among whom the most eminent was Fatio de Duillier, for a while his colleague at Paris, but afterwards residing near Geneva, where he made observations; of which, however, we have only a few records in Cassini's own work. Fatio de Duillier, however, is worthy of particular notice, as having, instead of Cassini's idea of reflecting particles originating in the sun, conceived that of particles of matter distinct from the sun, and arranged in shape like a "solid zodiac;" which body of uneven surfaces, and rotating around the sun, he supposed to give us the Zodiacal Light.* Observations were also made by Kirch and Eimmart, in Germany, from 1688 to 1694, and were published, but only a few of them in detail.

* "Il [M. Fatio de Duillier] me communiqua [7 October, 1684] l'hypothèse qu'il avait conçûe six ou sept mois auparavant. Elle a cela de commun avec ce que j'avais proposé dans le Journal du 1683, qu'il supposa dans l'éther des particules capables de detourner et de reflechir lumière. Il les disposa tout autour du soleil comme dans un zodiaque solide, large, et irregulier, compris entre deux surfaces courbes et ondoyantes, en sorte qu'elles puissent comprendre dans un moindre espace les orbites des planetes décrites autour du soleil, placées a diverses distances et inclinées diversément l'une vers l'autre. Le

Cassini had requested travellers in southern latitudes to give attention to the subject; and in 1684, Noel, a Jesuit priest in the East Indies, when near the equator, saw this Light so brilliantly exhibited, that he thought of giving it the name of the *Second Crepuscule*.

In 1687, M. de la Loubère, French envoy to Siam, saw it repeatedly; and in 1690, it was noticed at Pondichery; but the accounts we have from all these observers are little more than a simple notice that it was seen.

In 1731, Mairan, in his important work on the Aurora Borealis, took notice of the Zodiacal Light, to which he had given considerable attention; but his work affords us very little of a tangible and reliable character. He is remarkable for a theory that the Zodiacal Light is reflected from the sun's atmosphere, stretched out into a flattened spheroid, or lenticular-shaped body, revolving with the sun; an idea which La Place has forever set at rest, by demonstrating that the sun's atmosphere "can extend no further than to the orbit of a planet, whose periodical revolution is performed in the same time as the sun's rotary motion about its axis, or in twenty-five days and a half; that is, only as far as $\frac{9}{20}$ of Mercury's distance from the sun."

From the time of Mairan little seems to have been done on this subject, and we are scarcely furnished with a notice of it, until in 1796, the publication of the *Système du Monde*, in note 7 appended to it, gave the world La Place's nebular theory, and with it also a theory respecting the substance producing the Zodiacal Light. This great writer says: "If in the zones abandoned by the atmosphere of the sun, there are any molecules too volatile to be united to each other, or to the planets, they ought, in continuing to circulate around this star, to offer all the appearances of the Zodiacal Light, without opposing any sensible resistance to the different bodies of the planetary system, either on account of their extreme rarity, or because their motion is nearly the same as that of the planets with which they come in contact."—*Exposition du Système du Monde*, note 7, p. 471.

It will be observed that all the theories and all the reasonings on the Zodiacal Light, which we have in these various authors, seem to have been founded on Cassini's conclusion, that the axis of this light has a relation to the sun's equator, rising and sinking with it; which conclusion was drawn after only ten observations—the first detailed observations ever made. It is to be regretted that, in the one hundred and seventy years since his time, we have been furnished with so small an amount of facts instead of theories. My own observations, I believe, are the first, of any detailed character, ever carried into latitudes south of the equator, or even into regions about the equatorial line.

When the French corvette *La Bonite*, was about to start on her voyage of circumnavigation, in 1836, a special committee was appointed by the French Academy of Sciences to draw up instructions for scientific observations on board; and Arago was deputed by them to select matters connected with the *physique* of the globe. In his paper he enjoins particular attention to the Zodiacal Light; but even these very instructions themselves show how blindly the scientific world were then groping their way in a matter where facts only could give reliable evidence. He ends with saying, "Our young compatriots can, therefore, give themselves up zealously to the observations which we here designate. The question is important, and no one can yet flatter himself that he has given it a definite solution."

milieu de l'épaisseur qu'elles enferment est marquée par une surface pareillement courbe et ondoyante, qui passe par les orbites de toutes les planetes et détermine le milieu de la lumière. Les particules qui la renvoyent sont comprises dans l'orbe annuel au temps qu'elle parait. Il leur donne un mouvement par lequel elles vont ou sont portées autour du soleil par des cercles entiers, avec la même force que les planetes mêmes."—*Mem. de l'Acad. Roy. des Sci.*, tome viii. p. 158.

The subject appears, however, to have been entirely neglected by the officers and savans of *La Bonite.*

Soon after the wonderful meteor-shower of 1833, the subject of the Zodiacal Light was revived; and observations were made connected with the query, whether that extraordinary display of meteors was not owing to the passage of our earth, and its atmosphere, through the substance affording that Light. Our own eminent countryman, Professor Olmsted, with other gentlemen, at different observatories, were diligent observers, and with various results; going little, however, beyond the question of the meteoric shower and its cause. Biot, in France, came out as an advocate of this theory, and attempted to show that the shower was owing to the earth's passing, at that time, near the node of the Zodiacal Light. This led J. C. Houzeau to calculations, in order to see whether the nodes of the Zodiacal Light and sun do actually correspond; and, in the *Astronomische Nachrichten* of 1844 he has published the result of his examinations of fifty-eight observations on this Light, by nine of the most diligent observers, including Mr. Herrick, of Yale College, whose industry on this subject has never been excelled by any one. Houzeau thinks that, from these examinations, he has shown that these nodes are different; and that therefore "the supposition of the existence of this Light in the plane of the sun's equator does not satisfy the observations made." The closing sentence of his very interesting article gives the first intimation, and the only one that I have met with, that the Zodiacal Light has a near connexion with our own globe; and I will quote it at length. He says: "One is struck, without doubt, with the near approach which our elements show between the line of nodes of the Zodiacal Light, and that of the nodes of the terrestrial equator upon the ecliptic. This circumstance, as far as it is verified, may cast a new day upon the causes of this luminous phenomenon—causes which are, it may be, more local than have been hitherto supposed."

During the next year (*i. e.* in 1845), there was published in *Comptes Rendus* (vol. 16, pp. 687–8,) a letter from Mon. Ad. Matthiesson to Arago, detailing some experiments made at Paris, to ascertain whether there was heat connected with the Zodiacal Light. I give his remarks for whatever they may be considered worth. He says: "Monday, 27th March, at eight in the evening, a concave mirror, of one metre in diameter, highly polished, with a thermometer in air, very sensitive to heat, did not indicate any elevation of temperature. An elevation, however, was perceptible when the axis of the mirror was directed to the Zodiacal Light.

"The next evening I placed an excellent thermo-electric pile of Mr. Ruhmkopf, of twenty-five pairs, in a spot slightly hollowed out, between the *Arc de l'Etoile* and the *Bois de Boulogne.* The needle of the galvanometre rested at zero, when the pile, fortified with its cone condenser, was turned upon the polar star. Turned towards the tail of the comet above Orion, it remained at zero; towards the nucleus, the needle indicated two degrees. But the impression of heat gradually increased when the pile was turned towards the Zodiacal Light, after passing the tail of the comet: towards the Pleiades, 10° of deviation; towards the base of the Zodiacal Light, 12°; above the point where the sun had set, 5°. At 9 o'clock, the same result for the comet; towards the Pleiades, 8°; towards the base of the Zodiacal Light, 12°; above the point where the sun had set, 3°. At $9^h\ 30^m$, 7°, 10°, 2°, and the same result for the comet."

He thinks it, however, doubtful whether the increased temperature indicated when turned towards the Zodiacal Light, was owing to the substance giving that light itself, or to heat left in that portion of our atmosphere by the sun lately set.

In 1848, Professor C. Piazzi Smyth read before the Royal Society of Edinburgh a valuable paper giving account of observations made by him in South Africa some years previously, and also of an instrument invented by him for getting the position of the apex of the Zodiacal Light. To his paper (published in the Transactions of the Society, vol. xx, part iii) is appended an interesting exhibition of this phenomenon, as seen at the Cape of Good Hope in July, 1845.

There is only one subject more to be noticed in this history of observations on the Zodiacal Light. At the twenty-second meeting of the British Association for the Advancement of Knowledge (in 1852), a paper was read from the Kew Observatory, giving account of observations from January to April, 1850, by Mr. H. R. Birt. It has little in detail, and gives a statement, which is of little value, of the changes of inclination of the axis of the Zodiacal Light towards the ecliptic; but there occurs, moreover, the following passage in the records of the earlier part of March: "One evening, there was a sudden brightening of the light for an instant, and also variations in its lustre of an intermittent character. These intermissions of brightness were observed on the same evening by Mr. Lowe, of Nottingham. They are described by the author not to be of the nature of pulsations, in the usual acceptation of the term, but to consist of alternate brightenings and dimmings of the entire mass of light, such as might be produced by the approach and recess of a luminous body." (Am. Jour. Sci., xv, new series, page 121.)

Baron Humboldt also noticed similar appearances, as we learn from the following passage in his published works: "I have occasionally been astonished, in the tropical climates of South America, to observe the variable intensity of the Zodiacal Light. As I passed the nights, during many months, in the open air, on the shores of rivers and on llanos, I enjoyed ample opportunities of carefully examining this phenomenon. When the Zodiacal Light had been most intense, I have observed that it would be perceptibly weakened for a few minutes, until it again suddenly shone forth in full brilliancy," &c. (See Cosmos, vol. i.)

In our own country, some attention has been paid to the Zodiacal Light by individuals here and there; and our astronomers have been earnestly desirous of facts, on which to ground opinions; but without being able themselves to accumulate any extensive data, on account of the high northern aspect of our skies, and the low angle at which the ecliptic ranges with their horizon through much of the year.

MY OWN OBSERVATIONS AND THEIR RESULTS.

The historical items just given have been collected from various authorities since my return to the United States; for, previous to sailing on this cruise, I had given the Zodiacal Light no attention, more than to be aware that there was such a thing; and I had never seen it to know it as such.

I hope the reader will now pardon a little egotism in these remarks; for it is proper that he should know the circumstances of my observations, and thus be able to form his own opinion about their reliability and the results. While I was busy with preparations for the cruise, my friend, Professor Dana, of Yale College, suggested to me that I would have good opportunities for observations on the Zodiacal Light; but my mind was then fully occupied with other matters, and I could not have found time for resorting to libraries, or for making other preparations, if, indeed, I had known how they were to be made. Fortunately, at my last visit to my old home at the Naval Academy in Annapolis, off which our frigate was then lying, I pro-

cured from that institution a nine-inch celestial globe; and this, with an odd number of the American Journal of Science, containing some remarks by Professor Olmsted on the Zodiacal Light, and two of Nichols's works on Astronomy, were my only helps. The globe, published by the "Society for the Diffusion of Useful Knowledge" in England, proved, however, to be of uncommon accuracy throughout.

This very lack of the means of information, however, had its advantages; for I was thus kept from being drawn into the vortex of former opinions, or of being borne down by the influence of great names; and when, by and by, I became deeply interested in this subject, I was left to pursue my observations all the more carefully, and with the greater jealousy of mistake, from the fact that I had nothing to depend on but myself. Thus the data in this book are independent of all preconceived opinions, and I may add, also, in a great measure, of any opinions by myself; for I determined, in the first place, to get *facts;* and when I saw how frequently the dimness and indefiniteness of the Zodiacal Light would admit of self-deception, even where the intentions might be the most honest, I became jealous of myself to such a degree as not to allow myself, except in very rare cases, to refer back, or to compare present observations with those of any previous date. I also repressed in myself, as strenuously as I could, until the very last of the cruise, all disposition to form hypotheses; for I saw that my opportunities for observation were uncommonly favorable, and I wished to be faithful to my trust as an *observer*, and to have facts that could be relied on, whithersoever they might lead. The consequence of all this is, however, that there are incongruities and contradictions here and there in these lines of Zodiacal Light, or, at least, what appears to us to be such. Had I allowed myself to refer back, and so to guide myself along by former data, or to theorize, I could have made the results more symmetrical and more harmonious; but I declined seeking for symmetry, or even consistency, at such a risk. An hypothesis to go upon is often useful in sharpening observation; but it may also warp the mind and mislead, and I thought it would be too dangerous here; and my observations are not only independent of hypotheses, but, from the causes just stated, are independent also of each other.

It may seem to be, and perhaps is, inconsistent with the remarks just made, to say that, at an early period, the idea of a nebulous ring around the earth came up in my mind as applying more than any other to the case, and that it remained there to the last. I could not help *thinking;* and in those long, silent, night watches, thoughts of this kind would often be busier than I wished them to be. But I still tried to be faithful to my work as an observer, not a theorist; and if I swerved from this duty, I am not conscious of it, except in a single case. That exception I regret. It was where I had seen a light in the evening, ascending high in the *eastern* sky, (see July 7th, 9th, and August 5th, 1853,) and noticed it several times again the following year; but, concluding that it *ought* not to be the Zodiacal Light, I failed to make record of it at the latter period.*

My first observations were of an awkward, and for a long time they were of a very desultory, kind. I contented myself with making records of having seen the Light, and with giving its boundaries, by written descriptions, in a general way. But the necessity of *precision* soon showed itself; and, as I went on, of yet still greater precision; and I then constructed a star-chart

* P. S. Brooklyn.—I have regretted this still more since reading Baron Humboldt's remarks on this eastern light, in the *Astronomische Nachrichtung*, No. 989; and also an article by Theodore J. C. A. Brorsen, in No. 998 of the same periodical. The latter calls it by a very appropriate name, *gegenschein* (a shining opposite), and informs us that he made continuous observations on it for about two years. For a more extended notice of his observations, see the annotations in this book, No. 42.

from our excellent little globe. By laying folds of paper below this, and sticking pins through the stars, I multiplied the charts, till, after nearly a year's work in this manner, I was able to have the chart cut in wood at Canton, and thus I found myself well prepared for work. My custom was, at evening, to watch for the earliest appearance of the Zodiacal Light; and, as soon as I could get reliable boundaries, to notice their course among the stars, and draw these boundary-lines on the chart, with such annotations as the case might require; then, again, after the interval of half an hour or an hour, to go out once more, and as the boundaries would be changed in that time, to take the new ones in a similar way; and so proceed till the Light could be no longer seen: and thus also, in a reverse order, in the morning. And after having once fairly commenced—say about the first of March, 1853—I never failed for one evening or morning, (Sundays always excepted,) till our reaching home on the 22d April, 1855, to see, and, with one exception, to make record of the Zodiacal Light, when the moon and clouds did not interfere to prevent. In the case of that one exception, I saw the Light; but being shut up among the houses in Canton, I could not get reliable boundaries.

The development of facts in the Zodiacal Light came upon me gradually, and, before they had disclosed themselves, much valuable time in the high southern latitudes, at the early part of our cruise, was lost; on our return, however, we went still further to the south, and I was able to make amends in some measure for this loss.

There is no mention made, in any books on the Zodiacal Light, of any differences in the Light itself;* but I very soon began to notice that there was a Stronger Light at the central part, or along the axis; while, beyond this, on either side, and also above, a dimmer kind of light extended itself, as if the matter giving us this light was more condensed at its central parts, and was thinned out beyond. I have called these the *Stronger* and the *Diffuse* Light, and have marked the boundaries of the former on my chart by full lines, while the bounds of the Diffuse are designated by lines of dashes, each having the hours of the observation affixed to it. Sometimes, beyond the Diffuse Light, there was also what seemed to be, not a positive light, but rather as if the sky were slightly paled (if the reader will allow the word); so slightly, that I could not trust my own sight respecting it, till I had called in repeatedly the aid of other persons (see chiefly June 27th and July 1st to 11th, 1853). I have marked the boundaries of this last by *dotted* lines; but I consider it only as the more Diffuse matter greatly attenuated at its outer edge, which, by the sinking of the ecliptic towards the horizon, was now brought so as to make its reflection visible to us. In the case just referred to—that of July—it presently changed into the Diffuse Light itself. The Stronger Light is evidently the one of which Cassini has given the boundaries in his written accounts.

It is not to be supposed by the reader that any of these kinds of light was bounded by sharp lines easily detected in the sky. On the contrary, the Stronger passed by degrees into the Diffuse, and the latter also gradually faded away. Yet there was, in the former case, a line of greater suddenness of transition, which, when my eye had got accustomed to observations, I was generally able to make out without much difficulty; and this is the line or the boundary which is given in my charts. The outer boundary of the Diffuse Light was also tolerably well marked. That I was not fanciful in this, is shown by the frequency with which other persons on board, both officers and seamen, when requested to do so by me, and without any leading

* Unless, as seems probable, the following extract from Mairan's *Traité Physique et Historique de l'Aurore Boréale*, refers to such a difference: "J'ai encore observé plusieurs fois, qu'après que la Lumière Zodiacale avait cessé de paraître le soir sous sa forme de lance ou de fuseau, toute la partie du couchant demeurait plus eclairée que le reste du ciel, sur 30 ou 40 degrés d'amplitude." P. 36

questions, drew boundary-lines which corresponded exactly with those which I had just drawn, mentally, myself. Sometimes they differed from me; but still the promptness with which they designated such boundaries is proof that the transitions were perceptible to the eye. Generally, much careful looking took place, and perhaps repeated attempts, before I ventured to draw my lines. Often I was in doubt after all possible pains-taking, and the doubts are noted down. As a general fact, late in the evening the Stronger Light would melt away gradually, or rather would seem to be merged in the Diffuse Light, which alone would be left, the latter at first with a degree of brightness greater than it lately possessed; and then the Diffuse would pass away, in the increasing night. In the morning, the reverse was the case. It should be here observed, also, that this gradation in the strength of the Zodiacal Light was not only lateral from the centre outward, but also from the horizon upward to the terminating point. But the transition, in this latter case, was by insensible degrees, except in the cases of a more intense light near the horizon (to be noticed soon, and marked by zigzag lines on the chart); even the Stronger Light, towards its apex, was so dimmed as to be distinguished with great difficulty, and often I could make it out only by following up the boundary-lines from the lower portion. Sometimes, towards the last of these observations, I declined drawing the apex at all on the charts. (See Nos. 310, 314, &c.)

I remember very well my feelings of surprise and wonder when the *lateral* changes in the Zodiacal Light, as the night advanced, for the first time forced themselves on my attention. Those changes, as may be seen from my charts, are of constant occurrence; yet I do not find them noticed in any writings on this Light, except an allusion by Cassini in one of his observations, in which, however, he tells us that, both then and afterwards, he could come to no certain conclusions as to their existence.*

These changes, running all through the observations, will be found to be of great consequence when we come to draw conclusions from our data. They are greatest and most striking when the ecliptic has declined considerably towards the horizon; and there is great uniformity in them, but they are not without contradictions among themselves; as, for instance, No. 177,† where the lateral change ought apparently to be on the other or northern side; but these incongruities are rare, and are probably owing to extraneous causes.‡ I would not advise any one to draw conclusions from *exceptions*, in a matter where mistakes can be so easily made by the observer, but only from the general facts of this book; I have put down all, exceptions and incongruities as well as others, not feeling authorized to omit any portion; for who can say, in a new science, that what seem to be exceptions are not a part of the general rule?

Among the most important of these observations are those when the Zodiacal Light was seen near and at midnight, simultaneously on both the western and eastern horizons—a circum-

* "Je doutai si elle n'avait pas un peu de mouvement particulier vers le septentrion; car les deux plus luisantes d'Aries qu'elle frisait au commencement par son côte septentrional, furent ensuite comprises dans cette clarté; ce qui a été depuis confirmé par les observations des jours suivans. Mais je ne fus pas en être entièrement assuré ni alors, ni après plusieurs jours, parceque l'extremité de cette clarté était de tous côtes trop douteuse, s'afflaiblissant peu-à-peu; de sorte qu'il était extremement difficile de la déterminer précisement."—*Mémoires de l'Academie Royale des Sciences, tom. viii.*

† So also No. 101, where the 3 o'clock observation does not harmonize with the rest.

‡ Cassini remarks on the character of the Zodiacal Light as follows: "Il ne faut néanmoins prétendre réduire les apparances de cette lumiere a un règle aussi exacte que l'anneau de Saturne, parcequ'il s'en faut beaucoup qu'elle soit si bien terminée et qu'elle ait autant de consistence; étant assez évident, par les differences accidentales qu'elle fait paraître d'un jour a l'autre, qu'elle reçoit des variations reelles, outre celles qui viennent des causes externes, comme des diverses dégres de la clarte de l'air et du concours de la lumière des astres, et même de la disposition des yeux de l'observateur."—*Mémoires de l'Academie Royale, tom. viii. pp.* 163, 164.

stance never observed before.* I had not expected it, and the manner in which it came upon me is recorded in Nos. 93 and 94, with the care, also, to have other eyes than my own brought to bear on the subject, and also my carefulness in watching the western and eastern skies through all the changes of the light, from early in the evening till dawn. It is probable that this appearance can never be seen except when the ecliptic at midnight is at right angles, or nearly so, to the spectator's horizon; which can only be the case where his latitude is equal to the sun's declination, but on the opposite side of the equator. I saw this again in the following year (No. 266, &c.); and in both instances the ecliptic was not only vertical, or nearly so, at midnight, but bore east and west from me; but the latter circumstance, I presume, had nothing to do with the results. I have been puzzled to know by what kind of lines to designate the boundaries of this midnight Light; for it was very dim, quite as much so as the Diffuse Light; yet when I came to bound it by lines of dashes, I found they produced confusion when the Diffuse Light itself was marked down; so I gave it a line of alternate dashes and dots, and thus it is designated in the charts.

Some time early in 1854, I saw in a newspaper a brief notice of the pulsations in the Zodiacal Light seen at the Kew Observatory; but as the newspaper did not state where they were observed, or the authority, and as I had now been observing for a year without having noticed anything of the kind, I set it down as an ocular deception, and the thing passed entirely from my mind. But in March of this year (see No. 111), I was surprised, one evening, at seeing the Zodiacal Light fade sensibly away, dimmed to almost nothing, and then gradually brighten again. This was repeated several times; but the effect, after all, was to leave me only in amazement and doubt. Subsequent nights, however, gave abundant exhibitions of this kind, of which, with the times and changes, I have made ample records with the particularity that the case required. It was a great satisfaction, after my return home, to find that Baron Humboldt had observed the same thing while in southern latitudes, though he thought it more probable that it was owing to "processes of condensation going on in the uppermost strata of air, by means of which the transparency, or rather the reflection of light, may be modified in some peculiar and unknown manner." My records, however, will show that there is a regularity of appearance at the closing off of these pulsations, which proves that they do not belong to so uncertain a cause as atmospheric changes, but to the nebulous substance itself. They seem to intimate a great internal commotion in the nebulous matter, for they were too rapid to be occasioned by irregularities in its exterior surface.

I noticed them again the following year, but must refer the reader to my records and charts. The changes were a swelling out, laterally and upwards, of the Zodiacal Light, with an increase of brightness in the Light itself; then, in a few minutes, a shrinking back of the boundaries, and a dimming of the Light; the latter to such a degree as to appear, at times, as if it was quite dying away; and so back and forth for about three-quarters of an hour; and then a change still higher upwards, to more permanent bounds.

A reference to the charts will show zigzag lines in some of them (see Nos. 288 and 323, and almost *passim*) down near the horizon. These are the boundaries of a very effulgent light which appeared at the times specified, and within these bounds. It has no other distinction than its greater brightness, and the cause of it I cannot surmise. Cassini appears to have noticed the

* Unless, indeed, we class this with what a German writer calls the *gegenschein;* for which see notes to observation of August 5th, 1853.

same thing, as will be seen by reference to his annotations quoted in this book, fronting the chart 351.

I now, however, come to what may perhaps be the most important of all these observations; but a part in which my observations are meager, compared with the rest. I had, at an early period, queried whether the moon might not give a Zodiacal Light, and had given attention to the subject; but, probably, had looked too high up in the sky, and, at all events, had failed to see anything of the kind. But, one evening, when I was finishing some boundaries from the western sky, the quartermaster on duty said to me: "The moon is going to rise;" and, on crossing the deck, I was struck at once with the resemblance between the light then showing itself in the eastern sky and the morning Zodiacal Light, in every thing except its elevation. In breadth, in the peculiar boundaries laterally of the Zodiacal Light, and in coloring, it was all the same; and, in its subsequent rapid changes, it still kept strictly within the Zodiacal Light bounds. The following night I was prepared to make records; and I never failed afterwards to watch for recurrences of such light. But they did not often present themselves; for the ecliptic should be at a high angle, otherwise the light is apt to be so scattered along the horizon as to be unsatisfactory. It also happened, that we almost always had cloudy weather when such observations are most desirable—namely, at the full of the moon. For what was done on the subject, I must refer to the charts towards the close of this book, inviting attention more particularly to the observations of February 14th and 15th, 1854, and also to that of March 18th, of the same year, Nos. 331, 332, 335. In the last case, the Light appears to have extended far up (78°) into the sky.

On two occasions March 6th, and December 25th, 1854, I had also an undoubted *joint sun and moon Zodiacal Light*. That is, when the moon was about its first quartering*, and, at the time of the observations, about 63° above the western horizon, a bright streak appeared in the western sky, along the ecliptic; the joint light from the sun and moon, reflected from the nebulous matter, being apparently sufficient to overcome the bright moonlight in our atmosphere, and thus to make itself manifest. On both occasions I brought other persons to look (in the latter case, the captain and several other officers), whom I got to draw boundaries which corresponded to my own view of the subject. The latter occasion was also the more striking, because the streak of light did not stretch up exactly *towards*, but *to one side* of the moon, that satellite having then a southerly latitude of four and a half degrees.

The observations here given commence on the 2d day of April, 1853; for, although I had been a careful observer since December 22d of the previous year, I consider the interval as having been necessary in order to gain experience, and I have consequently rejected all up to the period mentioned. My first intention was to reject still more, and to commence this publication with June of that year; but the extraordinary interest of some of the observations in April, and the great care which I took in them to be precise as well as correct, have led me to insert them. The *unbroken* series commences at No. 10, June 7, 1853. From that time, till our arrival in New York on 22d April, 1855, every observation is recorded; and, except on Sunday, I never once failed to have observations, if the moon or clouds did not prevent.

Of the whole body of observations, however, I consider the last as more entirely reliable than the first; for I was all the while gaining experience, sharpening my observations by use. As an example, the reader will perhaps notice that in the morning observations of August, 1853, the Zodiacal Light boundaries are not carried as high up in the sky, as in the same month of

* March 1854, first quarter at Greenwich 6*d* 7*h*. December 1854, do. 26*d* 0*h* 37*m*.

the succeeding year. It is probable that, in the former case, the Light extended further up than is recorded—perhaps as far as in the latter case; but my eye then not being so accustomed to trace the dimmer markings of its higher portions on the sky, I failed to observe them. Some morning observations which I have made since my return home in August, 1855, confirm the higher altitudes. I was also, at first, not sufficiently careful in getting the exact curve of the effulgent Light (see Nos. 197, 199, &c., compared with 313 and 323, &c.), having been contented simply with noting the altitude of that peculiar brightness.

It will be seen that there is a full line with dots beneath, towards the upper part of most of the charts. These lines represent the course of the spectator's zenith for the hours given, and are intended to show his change of place as regards the ecliptic; so that we may know whether such changes have any connexion with the changes in the Zodiacal Light. They seem to have a very close and pretty uniform connexion. We must bear in mind, however, that these lines are his course *projected on the sky*, and that his real change of place is of infinitesimal amount compared with what we see it in the chart. Where there is but one observation, his zenith is represented by a dot with a circle around it. If his zeniths are beyond the limits of the chart, they are given in the opposite records. When the sun also could not be entered on the chart, his longitude is given on the opposite page.

In addition to this remark about the greater reliability of the latter portion of these observations, I would caution the reader against drawing conclusions from isolated data, if contrary to the general mass. In a matter so indefinite as the Zodiacal Light, and where mistakes are so easy, I was constantly liable to be misled; yet where appearances seemed to differ from those of the ordinary character, I never considered myself at liberty to do otherwise than to give them with their incongruities. But still, as already remarked, I should consider it dangerous to draw conclusions from such, or, at present, from any other than the general facts.

My opportunities for observation, it will be seen from these records, were very good. Of the seven hundred and fifty days included in my observations, three hundred and twenty-eight were spent within the tropics; and, in the balance of the time, our cruising extended from 41° 49′ N., to 53° 28′ in the south. The light always appears to best advantage near the equator; but we shall see, also, that the changes in latitude, from high north to high south, were of the utmost consequence, as regards results.

Whenever new phenomena, which were constantly occurring, threw me into doubt, and made me distrustful of my own eyes, or needing confirmation of their correctness, I could always find help among the night-watchers on deck; and also a choice of help, for sometimes I needed the aid of intelligent persons; and sometimes of others, who, without knowing what was meant, could only look, and tell me what they saw. My state-room was also on the quarter-deck, and within ten feet of the sentry at the cabin-door, who could wake me at any minute, for which orders had been left.

But though frequently calling in the aid of other eyes, as just described, and with very valuable results, still the observations here given are all my own; for I was satisfied at the outset of the importance of one pair of eyes and of one judgment, to see and decide in every case. And thus, although for six consecutive months, so sick as often to be unable to walk or stand without support, I still kept to my work; and the result, whatever it may be worth, has the merit of one uniform judgment trained by some experience, and stimulated, I know, by deep earnestness in the cause.

But I consider this as only the commencement of work. We need more facts. Those in this book are very few, compared with what are required in the case. It is my own purpose to make further observations, if possible, for a year or fifteen months, at some one spot, at or near the equator, so as to have comparisons, as the ecliptic passes at equal distances over head in the different portions of the year. And if my life is spared still further, I hope to continue my work to its end.

But we need many observers. One judgment may make mistakes—many of them, where mistakes can so easily be made. We need many judgments, so that one may correct another; and especially is it desirable that, for one year at least, there should be a series of simultaneous observations at the equator, and at points remote from it, both at the north and south. This I hope to be now able to effect.

At this stage of our work, effected and proposed, it may, perhaps, seem to be premature to draw conclusions; but still there are certain things that seem to force themselves on the mind from the data here afforded; and, if the conclusions which I shall now proceed to draw are not decisive to the reader's mind, they can at least furnish subjects for discussion that may, in the end, bring us to the truth.

DEDUCTIONS FROM THESE OBSERVATIONS.

§ I.

It seems to be quite conclusive, on an inspection of these charts, that *we never, at any one time, see the whole actual extent of the Zodiacal Light.* This subject can, perhaps, be elucidated by noticing a common event,—a cloud, silvered at one edge by the rays of the declining sun. The sun may be shining on the bordering, quite around that cloud; and, if so, it is sending off, from every portion of the border, an equally brilliant, silvery light. But our eye is in a position to catch this reflection from only one portion of it, and the rest is dull to our vision. If we could with great rapidity change our positions, other portions of the silvered edge would show themselves according to our changes of place. So, also, when a rainbow is presented to our eye: the myriads of drops of falling water in the whole rain-shower are sending off, from each drop, reflections of light in all directions, and the universal atmosphere about us is full of these brilliant, variously-colored rays; but only that portion which, to us, forms the rainbow-arch, can reach our eye, and all the rest is lost to our sight.

So it is also with the Zodiacal Light; and the proof that we never see the whole of its extent at once, is manifest in the following facts:

1. That when I was in a position *north* of the ecliptic, the main body of the Zodiacal Light was on the *northern* side of that line.

2. When I was *south* of the ecliptic, the main body of the Zodiacal Light was on its *southern* side.

3. When my position was *near* or *on* the ecliptic, this Light was equally divided by the ecliptic, or nearly so.

4. When, by the earth's rotation on its axis, I was, during the night, carried rapidly to or from the ecliptic, the change of the apex, and of the direction of the boundary-lines, was equally great, and corresponded to my change of place.

5. That, as the ecliptic changed its position as respects the horizon, the entire shape of the Zodiacal Light became changed, which would result from new portions of the nebulous matter

coming into position for giving us visible reflection; while portions lately visible, were no longer giving us such a reflection.*

* The first four of these results were not always uniform; but the exceptions were few, and were probably occasioned by the nebulous ring's not lying exactly in the plane of the ecliptic. In order to afford the reader a comprehensive glance at this very important and interesting part of our subject, I have drawn out a table, giving the number of each chart, and its bearing upon the above four general facts: *plus* signifying that the observation was in favor of, and *minus* against, that one of the facts whose number immediately follows. An asterisk to any number signifies that the observation referred to is of particular force. A note of interrogation means that the case is doubtful. The reader is especially requested to compare the evening observations of October, 1853, with those of December, in the same year. In both cases I was in the same latitude; but in October, I was far *north* of the ecliptic, in the evening; and in December, was nearly *on* that line; and the change in the Zodiacal Light boundaries is correspondingly great. Compare also the evening observations of March 16th, 1855 (No. 303), with the morning observation of the same night (No. 304). In the former case I was far removed from the ecliptic; while, before morning, I was brought close to it, with a corresponding change in the place of the Zodiacal Light. Compare also the whole series of observations from Nos. 49 to 82; where, in the morning, I was near the ecliptic, and in the evening, far removed from it. Observe also how, as in the latter part of October, and in November of that year (1853), I was each evening drawing rapidly more and more towards the ecliptic, the Zodiacal Light was also rapidly withdrawing from the north, and was drawing up towards the ecliptic line.

In constructing this table, I have had reference chiefly to the Stronger Light, as giving us the most reliable data.

No. 1 — 1	No. 48 + 1	No. 95 + 3 — 4	No. 142 + 1	No. 189 + 1	No. 236 — 1	No. 283 + 2
2 — 1	49 + 1	96 + 3	143 + 1	190 + 1	237 — 1	284?
3 + 3	50 + 1	97 + 3 + 4	144 + 1	191 + 1	238 + 3 — 4	285 + 2
4 + 1	51 + 1	98 + 3	145 + 1	192 + 1	239?	286 + 2
5 + 1	52 — 1	99 + 1	146 + 1	193 + 1	240 + 1	287 + 2
6 + 1	53 + 3	100 + 1	147 + 1	194 + 1	241 + 1	288 + 2
7 + 1	54?	101 + 1 + 4	148 + 1	195 + 1 + 4	242 + 1	289 + 2
8 + 1	55 + 3	102 + 1	149 + 1	196 + 1	243 + 1	290 + 2
9 + 1	56 + 3	103 + 1	150 + 1	197 + 1	244 + 1	291 + 2
10 + 1	57 + 1	104 + 3	151 + 1	198 + 1	245 + 1	292 + 2
11 + 1	58 + 1	105?	152 + 1	199 + 1 + 4	246 + 1	293 + 2
12 + 1	59 + 1	106 + 1	153 + 1	200 + 1	247 + 1	294 + 2
13?	60 + 3	107 + 1	154 + 1	201 + 1 + 4*	248 + 1	295 + 2*
14 + 1	61 + 1	108 + 1	155 + 1	202 + 1	249 + 1	296 + 2
15 + 1	62 + 1 + 3	109 + 1	156 + 1 + 4	203 + 1 + 4	250 + 1 — 4	297 + 2
16 + 1	63 + 1	110 + 1 + 4	157 + 1	204 + 1	251 + 1 — 4	298?
17 + 1	64 + 3	111 + 1	158 + 1	205 — 1	252 + 1	299?
18 + 1	65 + 1	112 + 1 + 4	159 + 1	206 + 1	253 + 1 + 4	300 + 2*
19 + 1	66 + 3	113 + 3	160 + 1	207 + 1 + 4	254 + 1 + 4	301 + 2*
20 + 1	67 + 3 + 4	114 + 1 + 4	161 + 1	208 + 1 + 4*	255 + 1	302 + 3
21 + 1	68 + 1	115 + 1 + 4	162 + 1	209 + 1 + 4*	256 + 1 + 4*	303 + 2*
22 + 1	69 + 1	116 + 1	163 + 1	210 + 1 + 4*	257 + 1	304 + 3
23 — 1	70 + 1	117?	164 + 1	211 — 1	258 + 1	305 + 2*
24 + 1	71 + 1	118 + 1	165 + 1	212 + 1	259 + 1 + 4*	306 + 3
25 — 1	72 + 1	119 + 1	166 + 1	213 + 1	260 + 1 — 4	307 + 3
26 + 1	73 + 1	120 + 1	167 + 1 + 4	214 + 1	261?	308?
27 — 1	74 + 1	121 + 1	168 + 1 — 4	215 + 1	262 + 1 ± 4	309 + 3
28 + 1	75 + 3	122 + 1	169 + 1	216 + 1	263 + 1 — 4	310 + 3
29 + 1	76 + 1	123?	170 + 1	217 + 4	264 + 1 — 4	311 + 3
30 + 1	77 + 3	124 + 1	171 + 1	218 + 1	265 + 1	312 + 3
31 + 1	78 + 1 + 4	125	172 + 1	219 + 1 + 4*	266 + 3	313 + 3
32	79 + 3	126 + 1	173 + 1	220 + 1	267	314
33 + 1	80 + 1	127 + 1	174 + 1	221 + 1 + 4*	268 + 4	315?
34 + 1	81 + 3	128 + 1	175 + 1	222 + 1 + 4*	269 + 4*	316 — 3 — 4
35 + 1	82 + 1	129 + 1	176 + 1	223 — 1	270 + 4*	317?
36 — 1	83 + 1 + 4	130 + 1	177 + 1	224 + 1	271 + 1	318 — 3
37 + 1 — 3	84 + 1 + 4	131 + 1	178 + 1	225 + 1	272 + 1	319?
38 + 1	85 + 3	132 + 1	179 + 1	226 + 1	273 + 2 + 4*	320 + 1
39 + 1 + 4	86 — 1	133 + 1	180 + 1	227 + 1	274 + 2	321 + 1
40 + 1	87 + 3	134 + 1	181 + 1	228 — 1	275 + 2	322 + 1
41 + 1	88 + 3	135 + 1 + 4	182 + 1	229 + 1	276 + 2	323 + 1
42 — 1	89 + 3	136 + 1 + 4	183 + 1	230 + 1	277 + 2	324 + 1
43 — 1	90 + 3	137 + 1	184 + 1	231 + 1	278 + 2	325 + 1
44 + 1	91 + 3	138 + 1	185 + 1	232 + 1	279 + 2	326 + 1
45 + 1	92 + 1	139 + 1 + 4	186 + 1	233 + 1	280 + 2	327 + 1
46 + 1	93 + 3	140 + 1 — 4	187 + 1	234 + 1	281 + 2	328 + 1
47 + 1	94 + 1	141 + 1 — 4	188 + 1	235 + 1	282?	

§ II.

*A plane, passing through the centre of the Zodiacal Light, as it shows itself through the varying latitudes of these observations, would correspond pretty nearly with the ecliptic;** but how near the two planes approach to a coincidence, it seems to be yet impossible to say. Through all of April, 1853, and December, 1854, there appear to be proofs of an evident crossing of the two planes. Through July of 1854, the apices, in the evening, were decidedly on the northern side of the ecliptic, though my latitude was only about 25° N.; while, in September of the same year, though my latitude was nearly as before, the apices were on the southern side of the ecliptic, as shown by my morning observations; the mornings then being very favorable for correct observation, on account of the high angle of the ecliptic with the horizon. Again, in April, 1855, the apices, and greatest body of the Light, were north of the ecliptic, even at times when I was, myself, to the southward of that line; as was the case in the first hours of the evening observations, up to the 13th of that month. The following general view rather shows us that there is something on this subject which may yet be learned, than that we have now the materials for anything definite and certain on the subject.

1853. April.—The planes of ecliptic and Zodiacal Light cross each other.
July.—By evening observations, the apex of Zodiacal Light appears to be north of the ecliptic. Morning observations are not satisfactory, either way.
1854. March 27 to April 18, strong proofs of crossing of the planes, by both morning and evening observations.
July.—Apex decidedly to the northward, by both evening and morning observations.
September.—Apices on the south, by morning observations, during this month.
December.—Apex decidedly to the northward, through all this month.
1855. January.—Apex as decidedly to the south of the ecliptic, by both morning and evening observations.
March.—Apex south of the ecliptic, by evening observations; the morning observations place it on the ecliptic.
April.—Apex north. No signs of a crossing of planes.

§ III.

This Light cannot be a reflection from our atmosphere, taking its shape from that; for this atmosphere, though brought, doubtless, by the axial motion of the earth, into a somewhat lenticular shape, must have its elongation directly over the earth's equator; and the course of the Zodiacal Light shows not the slightest affinity to the equatorial line.

§ IV.

This Light must be from something continuous and unbroken; not from a detached periodic body, either spherical or elongated; for, during more than two years' uninterrupted observations, I never failed to see it, either evening or morning, when the moon and clouds did not interfere.

* Which is the reason why I have chosen the ecliptic for the central line of my charts; and why I refer so often to the position of the spectator as regards the *ecliptic.*

§ V.

May not this Light be from a nebulous body of lenticular shape reaching to the sun, and lying in, or near, the plane of the ecliptic?

This query, I believe, comprehends Mairan's theory; and also that of many others of our own time, who, having abandoned part of his opinions, still hold to the lenticular shape. Mairan's idea of such a body connected with the sun, and revolving with that body, must be abandoned, for the reasons shown in page vii of this work. But may there, still, not be such a lenticular-shaped body, with the sun for its centre, yet not revolving with that luminary, but having a rotatory motion of its own?

The idea of a lenticular shape has doubtless arisen from the peculiar outline of the Zodiacal Light as presented, in its best and strongest aspects, to our eye. This Light being somewhat lenticular in shape, the body producing it is supposed to be similar in shape. But we must remember that, in order to draw such an inference, we must be *without* this lenticular body, looking down upon it; and that, to admit of this, its extent must fall short of our earth. But if it falls short of our earth, I could not have had the Zodiacal Light on both the eastern and western horizons at midnight; nor could it, in any observation, have reached far up in the sky; it could never, by any possibility, reach the spectator's zenith, which the Zodiacal Light is known very often to do.

If we suppose this lenticular nebulous body to *involve* the earth, and the spectator to be in its midst, looking through it, then the argument for a *lenticular* shape loses its force; for any other shape may give us such a result, if such a result can be given at all. But we may very well query, whether, if involved in the nebulous matter, and looking through it, we could get any distinct outlines by reflection from its particles, any more than, when involved in a fog, or in smoke, or in our earth's atmosphere, we can get their outlines. It is true that, when extraneous matters are mingled with these, we may get marked lines or boundaries in them, as we often do in our atmosphere from humidity along the horizon; but all this is from causes extraneous, and is not from the atmosphere itself; and it is also temporary in its nature.

It may also be said, that if we are involved in this nebulous matter, portions of it may give a reflection reaching our eye, while others do not; as it was asserted in § I that this matter actually does. Yet still it may be a subject of strong doubt, whether, if thus involved, the reflections could come to us with any such strongly-marked character, and with such distinct outlines, any more than they can come from our own atmosphere alone, while we are involved in its particles. My own impression is, that they could not.

There are, however, other difficulties in the way of this theory, which I will proceed to state:

1. This lenticular body having, in order to sustain itself, to rotate on an axis (which axis must be at the sun), and its diameter being more than 190,000,000 of miles, its portions near the centre and at its outer edge would require velocities entirely incompatible with each other. Either the inner portion would be drawn to the sun, from the want of centrifugal force; or the outer would fly off and be lost, from an excess of it; or the whole body, more probably, would soon resolve itself into a series of concentric rings, with intervals between them, somewhat according to Laplace's theory of the formation of our planetary system. But that there are no such concentric rings in this case, giving, by their combined effect, the Zodiacal Light, is evident from the fact that the light is continuous and regular, not broken into cross-bands or mottled, as would be the case, if from a number of concentric rings.

2. In the annexed figure, constructed to elucidate this theory, let A B C D G represent the outer edge of this supposed nebulous lenticular body; S, the sun; E, the earth; let the line G H be in the plane of the horizon of a spectator on the earth; taking for illustration the observation of September 4th, 1854, at $4^h\ 30^m$ a. m.; which observation is selected, not because it is of more applicability than any others in the book, but because it is a simple case, and because the observer at $4^h\ 30^m$ being near the ecliptic, a cross section *a b c c d d* of the lenticular body would be very nearly in the plane of his horizon; so nearly, that, in our reasoning, they may be considered the same. The lines of the spectator's horizons, of sufficient correctness for illustration, back to midnight, and also lines to his zeniths, are given on the diagram. The lines *e e e*, *f f f*, *g g g*, *h h h*, *i i i*, may represent the boundaries of the Zodiacal Light at $4^h\ 30^m$, $3^h\ 30^m$, $2^h\ 30^m$, $1^h\ 30^m$, and midnight; the points where each set strikes the horizons or sections *a b c d*, &c., in the nebulous lenticular body, being at the option of the reader.

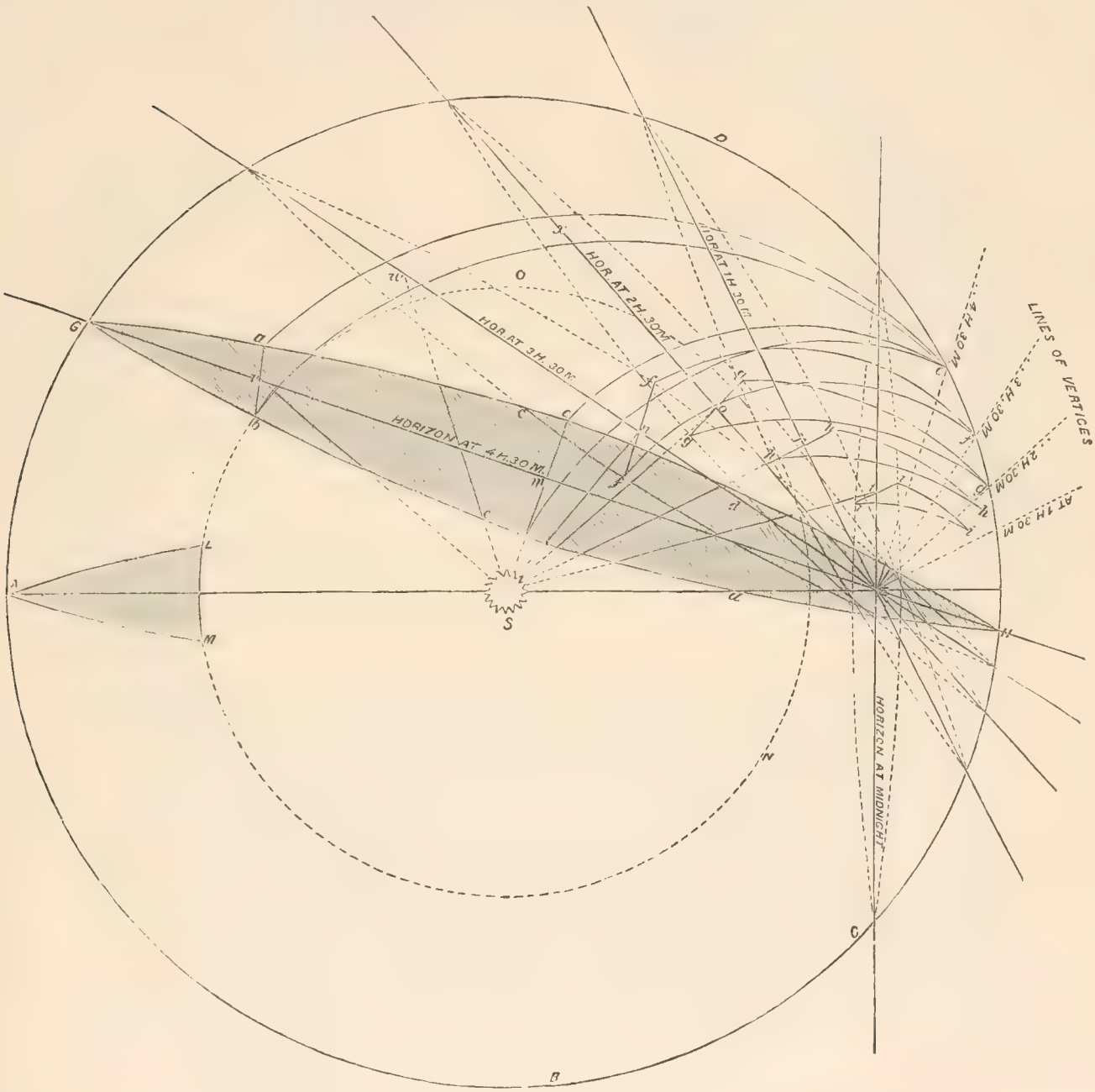
Now it will be obvious, that, from whatever portions of the lenticular body the Zodiacal Light comes reflected to the spectator at E, it must grow narrower as we recede back from the horizon at $4^h\ 30^m$, by the different horizons to that of midnight, the base *g g*, in the horizon at $2^h\ 30^m$, being much narrower than that of *e e*, in the horizon of $4^h\ 30^m$; and so to midnight, when the width must become very greatly reduced. But there is no such change in the actual width of the Zodiacal Light itself; but, on the contrary, though the various hours of the night make themselves felt decidedly in its brightness, they give us no perceptible change in its breadth; the base of the great body of the Light at $2^h\ 30^m$ having, usually, as great a width as at the dawn. Certainly there is no such a regular increase of breadth in the morning, or reduction in the evening, as such a theory would necessarily demand.

3. Objection 1 could be obviated by supposing the inner portion of this lenticular body removed, and only the outer part A B C D L M N O left as a *ring* enveloping the earth, retaining still its lenticular shape, of which A L M would represent a cross-section. In that case the lines *a b e* would have to represent the boundaries of the Zodiacal Light; and it will be seen that from somewhere about O to *a b*, these lines would have to be nearly parallel to each other, while from O to *e* they would have a different course; and, indeed, the whole shape of the Zodiacal Light would change, and be different in the different hours of the night, according as the horizons change; whereas one of the greatest characteristics of this Light is the regular uniformity of its shape.

4. There are two great laws with regard to light, from which a strong objection to this theory would probably arise; but it is difficult to apply them, in consequence of the uncertainty respecting those portions of the lenticular body from which the Zodiacal Light may be supposed to proceed. The laws referred to are: 1, That when light is reflected to the eye, the quantity reflected is in proportion to the greatness of the angle between the lines of incident and reflected light; and 2, that the strength of light is inversely as the squares of the distance of the object from which it proceeds. I shall, when considering Laplace's theory, apply these laws with more particularity; but, on account of the uncertainty referred to, can only advert to them in the present case. As the reader may wish to return to this diagram, and to study their application to it, I will add here the dimensions of the angles, which, in the imaginary case, would lie between the lines of incidence and reflection. They are, S *m* E, 91°; S *n* E, 97°; S *o* E, 89°; S *r* E, 89°; S *t* E, 74°; S *v* E, 21° 30′; S *w* E, 38°.

5. It appears to me, also, that if this substance involved the earth, the earth and moon, or one of them at least, would feel its effects upon their motions. The moon, in its revolution

SUPPOSED NEBULOUS BODY OF LENTICULAR SHAPE, THE SUN FOR ITS CENTRE, AND INVOLVING THE EARTH.



around our planet, would have this nebulous matter, in one half of its revolution, with it, and in the other half, against it; and let the nebulous matter have what tenuity it may, this difference would be perceived in the increased or retarded velocity of the moon; but no such difference of velocity is ever perceptible.

6. Our globe, having this matter close about it, would, by its superior attraction, soon draw its particles to itself, and make them a part of its own distinct existence, either as a ring to itself, or in some other way.

§ VI.

The great nebular theory of Laplace, according to which we have, in the formation of globes; first, an immense body of chaotic, nebulous matter, revolving about its own centre; next, a concentrated, central portion, producing, or being the sun, with the balance of the nebulous matter formed into a succession of concentric rings, according to the various specific gravities of the matter itself, all still revolving around the sun; next, these rings broken, and each rolled into a spheroidal mass rotating on its axis, and still also revolving about the sun, and thus giving us the various planets of our solar system; with a remainder of this ring matter too volatile for such condensation, and still continuing to form a nebulous ring around the sun, giving us, by reflection from its particles, the Zodiacal Light,—has been the theory usually adopted to account for this Light, since the publication of the *Système du Monde*. Laplace supposed this rotating ring to lie somewhere between the orbits of Venus and Mars, having, as just remarked, the sun for the centre of its motion.

Such a ring must be, necessarily, in one of the following cases: 1st, *Within* the earth's orbit; 2dly, *involving* the earth; or, 3dly, *without* the orbit of the earth.

§ VII.

1. It cannot be *within* the earth's orbit, for the reasons advanced in the § V—namely, that if so, we could never have the Zodiacal Light, at midnight, on both horizons simultaneously; and could never have it at any great altitude, at any period of the night.

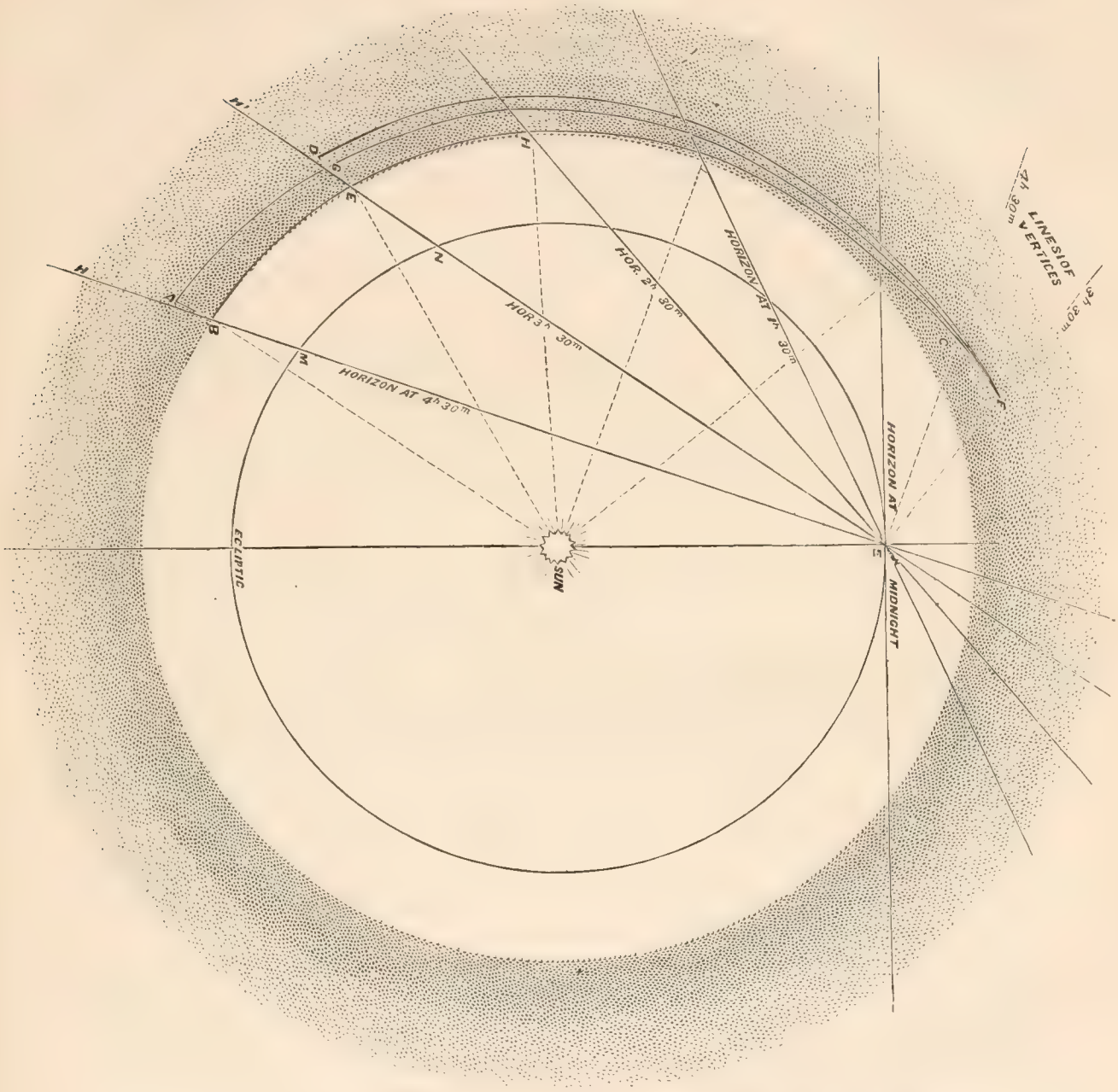
2. *Involving* the earth. The objection that if *involved in* the nebulous matter, we could not get outlines, or have any figure shaped by reflection from its own particles, as stated in the first part of the § V, will apply equally to the ring now under consideration. So, also, will objections 4 and 5 of the same §; for, although Laplace supposes that the ring may have a motion equal to that of the earth, or so nearly equal as not to make itself felt in the annual revolution of our globe, yet the moon in each of its revolutions would have to feel the unequally retarding force of this nebulous matter, and would show the effects in every revolution.

The laws of optics, soon to be noticed in detail, would also apply as an objection to such a ring, with a force that seems to be irresistible.

§ VIII.

A ring beyond the orbit of the earth.—For the consideration of this, I have constructed a diagram, in the centre of which is the sun; E, at the intersection of the lines of horizons, is the earth; and the dotted circle is the supposed nebulous ring, at an unknown distance from E, which distance we will suppose to be represented by the unknown quantity x.

NEBULOUS RING AROUND THE SUN.



We apply to this diagram, as a fair example, the morning observation of September 4, 1854: lat. 22° 18′ North. Sun rose at $5^h\ 48^m$; last observation of the morning $4^h\ 30^m$; previous one $3^h\ 30^m$. Let E H be the spectator's horizon at $4^h\ 30^m$, and E H^1 at $3^h\ 30^m$. Then E N will equal 158,900,000, and E M 179,100,000 miles*.

Let A B C represent the boundaries of the Zodiacal Light at $4^h\ 30^m$, and D E F at $3^h\ 30^m$: B E C F being the southern boundary, which was permanent; and A G C and D F the northern boundaries, at those respective hours. Now, by referring to the chart for that observation, it will be seen that the opposite sides of the Zodiacal Light, which, at $3^h\ 30^m$, at its base, were sepa-

* The reader will see that mathematical precision can scarcely be attempted in these numbers; they are offered only as such careful approximations as the case will admit of; but these are here sufficient.

rated by the distance D E; at $4^h\ 30^m$ in the same place were separated only by G E, being 3°, or 8,327,000 miles (+ the result of x) nearer to each other than at $3^h\ 30^m$. My own lateral receding northwardly from the ecliptic, during that time, was 236 miles.

Apply other cases, for which the same diagram will answer, with such changes as the reader's intelligence will easily supply.

January 30, 1854.—Morning: lat. 26° 10′ N. Sun rose $6^h\ 48^m\ 30^s$. In this case E N = 141,200,000 miles: the lateral change D G from 4^h to 5^h was 27,020,000 miles + the effect of x. My own lateral change from the ecliptic was 345 miles.

November 20, 1854.—Morning: lat. 36° 17′ N. Sun rose $6^h\ 46^m$. E N = 142,300,000 miles; the lateral change, D G, from 4^h to 5^h was 12,450,000 miles, + the effect of x. My own lateral change from the ecliptic was 185 miles.

January 9, 1855.—Evening: lat. 8° 47′ N. (The same diagram, reversing it, will answer for this.) Sun set $5^h\ 52^m$. E N = 161,000,000 miles; the lateral change D G from $7^h\ 20^m$ to $8^h\ 20^m$ was 7,740,000 miles + x. My own lateral change from the ecliptic was 245 miles.

March 16, 1855.—Evening: lat. 22° 55′ S. Sun set $6^h\ 12^m$. E N = 169,300,000 miles; the lateral change from $7^h\ 30^m$ to 8^h was 5,912,000, and from $7^h\ 30^m$ to $8^h\ 30^m$ was 12,780,000 miles. My own lateral change from the ecliptic in the half hour commencing from $7^h\ 30^m$, was 85 miles; in an hour, 205 miles.

These examples are taken as fair ones of lateral changes in the Zodiacal Light: much stronger ones abound in the book, and especially when the ecliptic had a low inclination to the horizon.

The query now arises, can such lateral changes, so uniformly observed as the evening or morning advanced, agree at all with the idea of a nebulous ring giving this light at a distance from the spectator of 160 or 180 millions of miles? A ring of the character supposed, it seems to me, could give us a Zodiacal Light only of one uniform shape—namely, with the opposite boundaries receding from each other for a short distance from the apex, and then running parallel, one to the other, the whole way down to the base. Nor could the hourly changes of time produce any other change in these boundaries than a rising or sinking of the apex of the Light; the boundaries, say at 9 o'clock, p. m., extending a little higher in the sky than at 8; but, immediately after leaving the apex, running into those of 8, and so continued, with a parallelism of the opposite sides, down to the horizon. How different this is from the true facts of the case, almost every chart in this book will testify.

The evident and most decided connexion between these boundary-lines and the spectator's place, as regards the ecliptic, is also a matter of the greatest significance in drawing our conclusions respecting the origin of this Light. In § I, of these deductions, this matter is stated in detail. Now, supposing the base of the Zodiacal Light to be at a distance of 200,000,000 miles: how is it possible that the fact, that the spectator is a short distance north or south of the ecliptic line, can govern the reflection from the nebulous ring at that immense distance, and place it on his side of the ecliptic? If he is on the north side, not only is the main body of the Light, down to its base, on that side; but the lateral changes of the boundaries, as the hours pass, are altogether or chiefly on that side; and so equally with the south. And so, if he is on the ecliptic, or near it, the Zodiacal Light stretches equally, or nearly so, on each side of that line. Also, if he changes rapidly during the night to or from the ecliptic, the boundaries of this Light also change, being regulated by his motion. That the *apex* of the Zodiacal Light, from such a ring around the sun, might be so affected by the spectator's position, is not an unreasonable supposition, since the ring may approach the earth sufficiently for such a result; but, that the

boundary-lines toward, and at, the base, should be so affected, seems to be utterly inadmissible.

It is worthy of remark, also, how even and uniform, from apex to base, the change in the boundary-lines is, as the hours change; as if the substance giving the Zodiacal Light were not only *near*, but also at *one uniform* distance from the spectator; the portions of it at the apex and base of the Light all *equally* affected by his changes on the earth.

We come now to apply to this case the two laws of light referred to in § V; and I will give one of them more in detail, leaving to the reader to apply them also to the diagram in § V, according as he may choose his positions there for the Zodiacal Light.

A great number of experiments on the strength of light reflected at various angles have been made in France, and are given by the experimenter, Mons. Bouguer, in his *Traité d'Optique sur la Gradation de la Lumière.* He says: "But what is more remarkable in the mathematical surfaces which we have just been considering, is the fact that the reflection is not equally bright under all the angles of incidence.* In general, it is stronger under small angles, and more feeble under larger ones. The difference is exceedingly great when the rays strike, with different obliquities, the surface of very transparent bodies, but it is nearly as great in cases of certain opaque bodies; and I have never known it to fail altogether in any."

Among the results of his experiments, he gives us the following tables, in which are shown the number of reflected rays out of 1,000, falling, at various angles, on a smooth surface of water, and on mirror-glass not quicksilvered. I have added a column converting his angles of incidence into the angles between the incident and reflected rays.

WATER.			MIRROR-GLASS NOT QUICKSILVERED.		
Degrees of angles of incidence.	Degrees between the lines of incidence and reflection.	Number of rays reflected out of 1,000 incident rays.	Degrees of angles of incidence.	Degrees between the lines of incidence and reflection.	Number of rays reflected out of 1,000 incident rays.
½	179	721	2½	175	584
1	178	692	5	170	543
1½	177	669	7½	165	474
2	176	639	10	160	412
2½	175	614	12½	155	356
5	170	501	15	150	299
7½	165	409	20	140	222
10	160	333	25	130	157
12½	155	271	30	120	112
15	150	211	40	100	57
17½	145	178	50	80	34
20	140	145	60	60	27
25	130	97	70	40	25
30	120	65	80	20	25
40	100	34	90	0	25
50	80	22			
60	60	19			
70	40	18			
90	0	18			

The want of entire certainty in applying such results to the present case of nebulous matter, must be conceded; for we know not what nebulous matter is, and we cannot go beyond sur-

* By angle of incidence, as he informs us, he means the angle between the incident ray and the surface of the reflecting body—"*avec la surface et non pas avec sa perpendiculaire.*"

mises as respects most of its properties: yet it is evident to our senses that Bouguer's law, that the quantity of rays reflected is greater, the greater the angle between the incident and reflected light, applies to vapory particles (as we see in the reflection from clouds), and also to the molecules of our atmosphere; and we may, I think, presume that it applies also to nebulous matter, which, though seemingly a dense substance, has still nearly the transparency of our atmosphere.*

Referring now to the diagram, we find that, at the base of the Zodiacal Light, at $4^h\ 30^m$, the angle between the incident ray S B, and the reflected ray B E, is 15°; at the base at $3^h\ 30^m$, it is 25°; at $2^h\ 30^m$, it is 36°; and at $1^h\ 30^m$, it is 45°. Thus the angles, we perceive, go on increasing from the horizon at $4^h\ 30^m$ up to that at midnight; and allowing that, below 40° between the incident and reflected ray, there is no perceptible difference in the quantity of the reflected light, we should from this law have the Zodiacal Light of the same intensity the whole way, from the base at $4^h\ 30^m$, up to its apex. But the other law of optics referred to—namely, that the strength of light is inversely as the squares of the distance of the object affording the light—would here make its application; and this ring at our zenith being about 140,000,000 of miles nearer to us than at the base at $4^h\ 30^m$, we should then have the Zodiacal Light far more intense at the apex than at the base; at the base, at $2^h\ 30^m$ it would be much stronger than at $3^h\ 30^m$; and at $3^h\ 30^m$ stronger than at $4^h\ 30^m$; all which is entirely opposite to the facts of the case.

§ IX.

I offer now, as a last conclusion, the hypothesis of a nebulous ring, with the earth for its centre.—There are certain deductions which appeared to come up in the examination of the preceding theories, which I will now bring together, and exhibit in a united form. They are: 1. That the substance giving us the Zodiacal Light must be *equally near* to us in all its parts, inasmuch as the lateral changes of the Light—*i. e.* the changes of boundaries—have a uniform character, and mostly a parallelism in their whole extent from apex to base; 2. That no part of this substance can be *very remote* from us, inasmuch as the outlines of the Light were clearly and decidedly affected by my own position on our globe, and even by my change of position, in a single night; and 3. That the laws of reflected light require an arrangement, or a shape, of this nebulous matter, which will give us, at the base of the Zodiacal Light, larger angles between the lines of the incident and reflected light, than at other portions, and also a regular decrease of such angles from the base to the apex of the light, as produced by such a shape. These three requirements appear to be fully met by an hypothesis, which, if the theories examined in the preceding § are untenable, is now the only one remaining to us.

The hypothesis is that of *a ring around the earth.*

The thought is a somewhat startling one, yet startling only from its novelty; for it is entirely in accordance with what we know of one of our sister planets (Saturn), and also with the whole of Laplace's celebrated theory of the formation of globes.

That great writer, after stating his ideas of the central condensation from an immense body of nebulous, rotating matter, and thus of the formation of our sun, and of the rings about him, produced from the remainder of that nebulous matter, thus proceeds:

"If all the particles of a ring of vapors continued to condense without separating, they would at length constitute a solid or a liquid ring. But the regularity which this formation

* I could, in clear nights, with the naked eye, easily make out stars of the 6th, and I sometimes thought of the 7th magnitude, through its densest parts.

requires in all the parts of a ring, and in their cooling, ought to make this phenomenon very rare. Thus, the solar system presents but one example of it—that of the rings of Saturn. Almost always each ring of vapor ought to be broken into several masses, which, carried on with velocities differing little from each other, would continue to circulate at the same distance around the sun. These masses ought to take a spheroidal form, with a movement of rotation in the direction of the rotation, since the inferior molecules have a motion less than the superior ones; they have thus formed so many planets in a state of vapor. But, if one of them has been sufficiently powerful to unite, successively, by its attraction, all the others around its centre, the ring of vapor will have thus become transformed into only one spheroidal mass of vapors, circulating around the sun with a rotation in the same direction as its revolution. Now, if we follow the changes which further cooling ought to produce in the vapory planets, of whose formation we have just spoken, we shall see grow up in the centre of each of them, a nucleus, incessantly increasing by the condensation of the atmosphere which surrounds it. In this condition, the *planet* resembles perfectly the sun in the nebulous state, in which we have just been considering it; the cooling ought, then, to produce, at different limits of its atmosphere, phenomena similar to those we have described; namely, rings and satellites circulating around *its* centre, in the direction of its motion of rotation, and turning on their axes in the same direction."—*Système du Monde. Paris edition: pp.* 467–468.

This great theory of Laplace, called his nebular theory, appears to be looked upon by astronomers with wonder, almost with awe, and as a thing which they may scarcely dare to touch. It is regarded with favor, yet there are few cosmologists who venture a decided opinion upon it; and, indeed, while there are few points from which it can be controverted, Laplace himself seems to have exhausted what can be said in its favor, in the few lines which he has given to it, in a manner far from positive, and in a retired corner of his book. If that theory be true, however, we have reason to think that no one of the planets may have absorbed in itself all the nebulous matter of the ring from which it was originally formed; and that, consequently, there may be, to each of them, a remainder substance, in the form of a ring, or rings, with the planet for its centre. In the case of Saturn, such rings are visible by the aid of our glasses. To Jupiter, such rings have given four satellites; for our own globe, one satellite has been produced. And we may well query, whether there may not be still a remainder of the nebulous matter left from the ring originally producing the earth; the nebulous substance of that ring not having been all exhausted in the formation of our earth and its moon, and showing itself in a ring such as we are now considering.

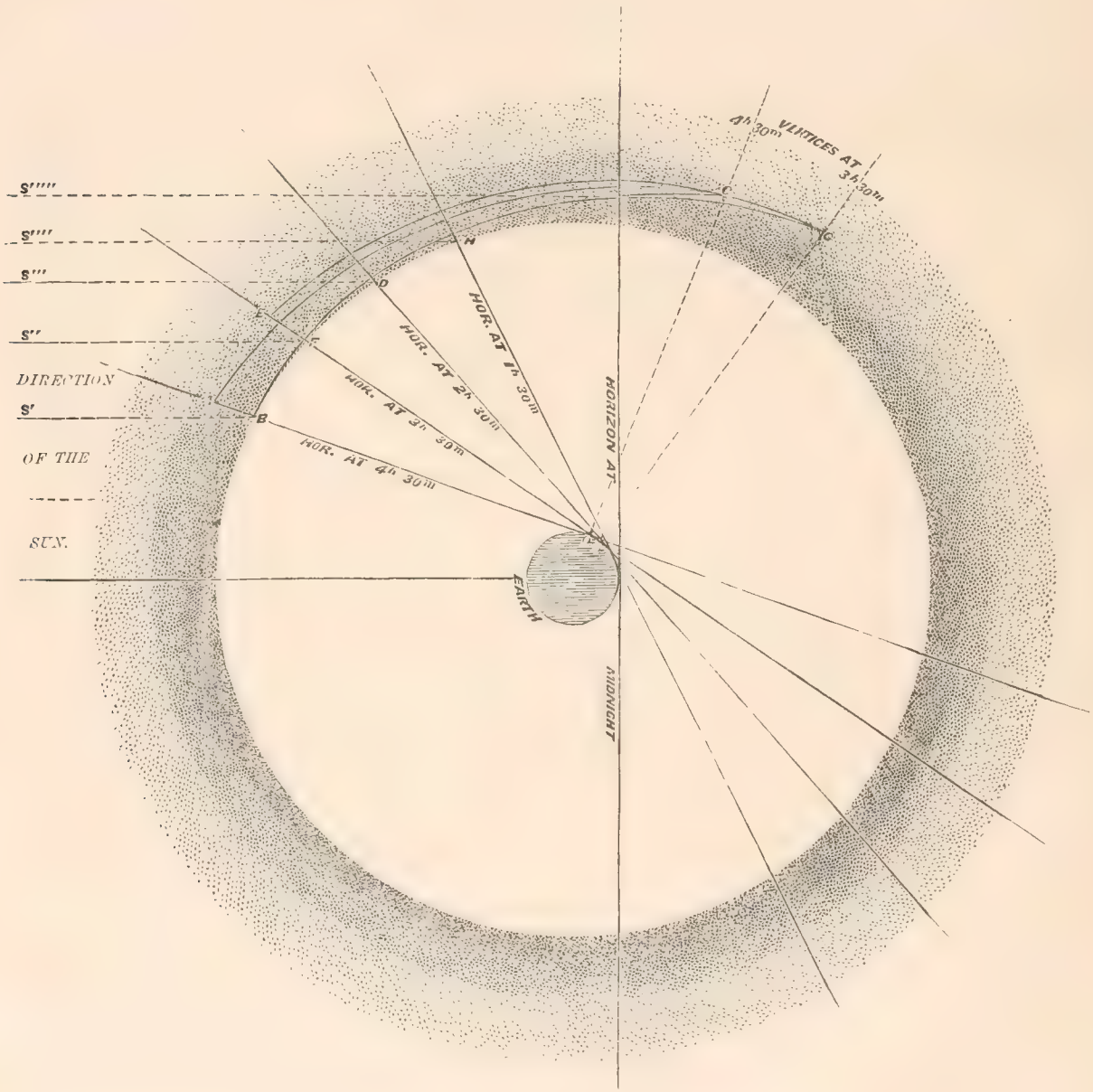
But, avoiding any consideration of these topics, as regards other planets, and confining ourselves simply to the facts of the Zodiacal Light, and of a ring central to the earth, to which they seem to lead us, we proceed to apply the results of Bouguer's experiments to this case.

In the annexed diagram, constructed according to this supposition,* the observation quoted in the former sections—that of September 4th, 1853—is again taken as an example, and for the same reason; namely, that it is a simple one, and one also in which the spectator is near the plane of the ecliptic. The horizons, at $4^h\ 30^m$, $3^h\ 30^m$, $2^h\ 30^m$, $1^h\ 30^m$, and at midnight, are given, together with the lines of the spectator's vertices, as well as his positions, *o o*, &c., at $4^h\ 30^m$ and $3^h\ 30^m$, &c. A B F C are the boundaries of the Zodiacal Light at $4^h\ 30^m$, and

* The relative proportions of the earth and the ring, and also its distance, are, of course, not given in this diagram with any effort at certainty; the upward extent of the ring is probably far greater than can be here represented. The diagram is, however, sufficiently correct for our present purposes of elucidation.

E F G at $3^h\ 30^m$; the apices C and G are carried a little above the more condensed portion of the ring; but the reader is at liberty to suppose them to be at any other part, as he may think best. The direction of the sun is given; and S′, S″, S‴, S⁗, S⁗′, are supposed to be rays of light proceeding from that luminary.

NEBULOUS RING, WITH THE EARTH FOR ITS CENTRE.



In this diagram, the sun's rays being S′, S″, &c., B O, F O, &c., will be the reflected rays; and the several angles between these lines of incidence and reflection, together with the number of rays reflected to the eye, out of every 1,000 incident rays, according to Bouguer, are in the following table:

Angle.	Rays reflected from smooth water.	Rays reflected from plate-glass not quicksilvered.
S′, B O..... 161°	343	422
S″, F O..... 146°	184	270
S‴, D O..... 131°	101	162
S⁗, H O..... 116°	59	105
S⁗′, at midnight, 90°	18	25
S⁗″, C O..... 67°	18	25

Still acknowledging that we know not what nebulous matter is, and therefore that we cannot, with certainty, argue about its properties of reflection; yet still claiming as a high probability, amounting almost to certainty, that the laws of reflection, applying to all other bodies, to solids, to vapors, to the molecules of our atmosphere, apply also to nebulous matter, we find in the above table a strong argument for such a ring around the earth. The figures, taking either of the two columns, for water or for glass, correspond in a very striking degree with the varying intensity of the Zodiacal Light, from the base upward, as we have it on any clear morning or evening when the ecliptic is at a high angle with the horizon, and when, consequently, the nebulous figure is not brought angularly to our eye. They also correspond to what is, indeed, almost synonymous with that which has just been stated—namely, to the fact, that at $4^h\ 30^m$, the Zodiacal Light at the horizon is far greater at its base than it is at $3^h\ 30^m$; at $3^h\ 30^m$, than it is at $2^h\ 30^m$, &c., back to midnight. Any person, who has ever looked attentively at this Light, when making a high angle with his horizon, will see at once the coincidence between the proportions in the above figures, showing the number of reflected rays, and what has been always presented to his eye. If the reader will also carry these lines of incident and reflected light beyond the midnight horizon-line, to any point there of the nebulous ring, he will see how we may easily get what is referred to in my charts under the German name of *gegenschein—i. e.* a dim light, seen, when the circumstances are favorable for it, in those portions of the sky opposed to the sun. This hypothesis shows also, very clearly, how I could have the Zodiacal Light above both horizons at the midnight hours, as I was often able to do, and it harmonizes fully with the strength of the Light as then presented to the eye.

Indeed, while Bouguer's results are antagonistic to all the theories discussed in the previous sections, and seem to be utterly irreconcilable with them, they fully coincide with this, in every one of its aspects; and, so far as they can go, they satisfy the mind, in all the varying characters of the Zodiacal Light.

I said, so far as they can go; for there are points in this subject, such as the pulsations of light, and what in the annotations to these charts is called the "effulgent light," which belong to something in the nebulous matter which we have not yet fairly reached, and which must be left for explanation to yet further observations.

While there are some things still left unexplained, I have, yet, not been able to see any thing in this hypothesis antagonistic to the facts of the Zodiacal Light. On the contrary, almost all of them are explained by it; and they all, as far as I can perceive, fully harmonize with it, through the whole of the manifold changes which the light underwent, either from the changes of the ecliptic towards any fixed spot, or from my numerous and great changes of latitude during our cruise. But, for this, I must refer the reader to the charts and annotations of this book. In examining them in detail, we must remember the deduction just drawn in § I, from

the general mass of data—namely, that as the spectator's place is changed relatively to different portions of the nebulous ring, such portions change, for him, their reflected light; just as is done every day, to our eye, by clouds or other terrestrial objects. Remembering this, he will, I think, fully understand why, when I was on the northern side of the ecliptic—*i. e.* towards the northern edge of the ring—its reflection was chiefly on that side; why its southern portions gave me the chief reflection when I was towards its southern side; and so, why all the various aspects detailed in Nos. 1, 2, 3, 4, and 5, of § I, were, at different hours or seasons, presented to my eye.

If it should be objected to my deductions from Bouguer's law of reflection, that the intensity of light, which his results would give this ring when brought between our eye and the sun, ought to make the ring a very striking object to us during a total eclipse of the sun; I reply, that the increased intensity of the Zodiacal Light, from the apex to base, is a *fact* independent of any theories; that, on any supposition of causes, it can scarcely be doubted that this reflection, so increasing from apex to base at the horizon, goes on still increasing in force below the horizon, towards the direct line between our eye and the sun; and that, consequently, if the Zodiacal Light is not a striking object in a total eclipse, stretching off from each side of the sun, this fact is not more against the hypothesis of a ring around our earth, than against a ring around the sun or in any other place. As respects such eclipses, however, if the observer of them is in a high latitude, north or south, he will, except at only one portion of the year, have the ecliptic at a very low angle with his horizon (even, under the best circumstances, not at a high angle), and therefore cannot expect to have a good exhibition of the Zodiacal Light at the time of eclipse. There was, however, an observation made in Peru, during a total eclipse, on the 30th of November, 1853, from which we might expect something of a more decisive character. The observer was Professor Carlos Moesta, of the Observatory of Santiago, who, at the suggestion of Lieutenant Gillis, U. S. N., was sent to Peru, by the government of Chili, for that purpose, and who afterwards made a highly interesting and valuable report to the Minister of Public Instruction, with a sketch of the heavens as they appeared at the time of the total obscuration of the sun. His place of observation was in lat. 14° 21′ 21″ S., and consequently he had the ecliptic at a high angle with his horizon: the sun at that time having a declination of 24° 42′ S.—*i. e.* 7° 21′ south of the observer. Every thing was favorable, as regards an observation for the Zodiacal Light, on that occasion; and we have, in his engraved plate, in addition to the corona usual in total eclipses, a long ray projecting from the sun S. 70° E., and another, also a prominent and striking object, but not quite so long, stretching off N. 80° W. He says: "Nearly all the northern part of the ring [corona] was uniform; the opposite side was evidently composed of numerous rays, which appeared to come from the ring, and all which had the same length, with the exception of two very large ones. Of these last, one was in an upward direction, and inclined about 20° S. of E., and according to estimation, its upward extent is as large as a diameter of the moon; the other extended from the ring downward, not diametrically opposite to the former, but inclined about 10° N. of W., and was a little shorter than the other. The appearance of these two rays was much like that of a comet, narrower at the end than near the nucleus, and clearly radiating in its structure; since it could be seen, perfectly well, that these rays were not of a homogeneous light, but composed of a vast number of very small rays. Soon after the eclipse I made the annexed sketch, in which I have endeavored to represent this ring [corona] as nearly like the original as possible."

It should be added to this, that Mr. Moesta's drawing was from a view through the telescope;

I have, myself, always found the naked eye better for viewing the Zodiacal Light than telescopes. Through our ship's glasses I was never able to see it at all.

If we could have a Zodiacal Light of an undoubted character produced by the *full* moon, not only would the question before us be set at rest, but the ring would be shown to be within the orbit of the moon; and how near we came to a case of that kind on the evening of February 14*, 1854, the reader will decide for himself. There was no subject connected with these observations, in which I was so carefully watchful; but, in summer, the moon, when full, must rise long before the crepuscule ceases, and it is only in winter months that satisfactory observations of this nature can be made; and in the few instances of this kind which offered, clouds interfered to prevent them.

For myself, I have no doubt that what I saw, in all the cases given in these charts, was really *Zodiacal Light produced by the moon.* When the equator and ecliptic were furthest removed from each other, the Light still kept closely with the ecliptic, and, therefore, could not have been atmospheric; and the boundaries, though only in one case having the altitude of the sun's Zodiacal Light, still, as far as they ascended, always resembled fully those produced by the sun.

§ X.

From the deductions made in § I, it is apparent that we cannot expect to get a parallax of this ring; and that we can hope for only approximations to its width. In the morning observations Nos. 137, 145, 157, 159, I appear to have got the full lateral extent northward of the Stronger Light, about 30°; and in No. 130, of the Diffuse Light 45°; but the evening observations of June, July, and August, 1853, differ somewhat from these. The inference from the whole of these data would seem to be about 60° for the full width of the Stronger, and 90° for that of the Diffuse Light.

I endeavored to have simultaneous observations made in Connecticut while I was in the extreme southern latitudes, but did not succeed.

§ XI.

This ring must, according to the laws of matter, rotate on its centre; and it seems to be full of commotions within itself. The existence of the pulsations, so often referred to in this book, seems scarcely to admit of a doubt, recorded as they have been by observers in such distant quarters of the globe. They were, as a general thing, very obscurely marked; but at times they appeared to be so decided that I had no longer a doubt of their reality. They could scarcely be owing to irregularities on the surface; for the changes appear to have been too rapid and extensive for such a cause. But that is possible. The following, respecting the rings of Saturn, is from Laplace's *Mécanique Céleste:* "Hence it follows that the separate rings which surround the body of Saturn, are irregular solids, of unequal width in the different parts of their circumferences; so that their centres of gravity do not coincide with their centres of figure. These centres of gravity may be considered as so many satellites, which move about the centre of Saturn, at distances depending on the irregularities of the parts of each ring, and with velocities of rotation equal to those of their respective rings."—*Bowditch's Tr.*, vol. v, p. 516.

If we allow an irregularity of width to the earth's ring, it may account for the changes in its intensity of light; the Zodiacal Light this spring (1856) having been considered as of much greater brightness than in previous years.

* The moon was full at Greenwich February 12, 14*h.* 56*m.*; allowing for the difference in longitude, the observation was 1*d.* 6*h.* 43*m.* after the full; the next evening's observation, with still more decided results, was 2*d.* 7*h.* 28*m.* after the full.

§ XII.

If this nebulous matter gives us its reflected light only from certain portions of it—*i. e.* only from portions in position for admitting such reflection to our eye, as seems to be shown in § I—may not the light from the tails of comets* (query: portions of *very* elliptic rings, the plane of the rings then coinciding with our eye?) be given and withdrawn in the same manner; so that, instead of such appendages suddenly shot out, and as suddenly withdrawn or dissipated, and at times, contrary to all laws of dynamics, preceding the body from which it emanates, we have, more philosophically, a substance always permanent, but giving its light to our eye only in certain portions of its orbit?

In conclusion, I wish here to express my acknowledgments for indulgences and kindnesses often received from the officers of the United States frigates "Mississippi" and "Macedonian," while in the prosecution of my work; especially from Captain S. S. Lee, of the former, and from the late Commodore Abbot, of the latter ship. I owe, still more, my most hearty thanks to Commodore Perry, who never failed to encourage others in useful efforts, while himself leading successfully in an honorable and glorious enterprise.

GEORGE JONES.

Brooklyn, New York, *May* 26, 1856.

* "The tail of the great comet of 1680, immediately after its perihelion passage, was found by Newton to have been no less than 20,000,000 of leagues in length, and to have occupied only two days in its emission from the comet's body; a decisive proof, this, of its being darted forth by some active force, the origin of which, to judge from the diameter of the tail, must be sought in the sun itself."—*Sir J. Herschell's Outlines of Astronomy.*

As this book may come into the hands of foreign astronomers, to whom the author's name will be new, and who may wish for some introduction and vouchers for reliability, he offers the following letters—written, however, for another purpose—but which he has still the writers' permission to print:

CAMBRIDGE, MASSACHUSETTS, *July* 5, 1855.

DEAR SIR: We have examined with great interest the valuable results of your observations upon the Zodiacal Light during your cruise with Commodore Perry's expedition, and have much pleasure in being able to bear our testimony to the importance of these observations. From even the superficial examination which the nature of the case permits, we have been strongly impressed with the richness of the materials for thorough and successful study of the Zodiacal Light, which have been collected by your unwearied zeal, applied under peculiarly favorable circumstances.

There can be no doubt that a careful study of your charts will develop new and important facts; and we consider it of the highest importance that the complete series may be published, without abridgment, and thus rendered accessible to all who may wish to pursue the study of the curious phenomena which you have so diligently and successfully observed.

We are, dear sir, with much respect, your friends and servants,

(Signed) BENJAMIN PEIRCE,
[Perkins Prof. of Astronomy and Mathematics, Harvard University.]
B. A. GOULD,
[U. S. Coast Survey, editor of Amer. Astronomical Journal.]

Rev. GEO. JONES, *Chaplain United States Navy.*

YALE COLLEGE, NEW HAVEN, CONN., *May*, 1855.

The undersigned have seen, and examined in part, the charts and observations on the Zodiacal Light made by Rev. George Jones, while under your command, in the Japan expedition.

In our estimation, they are rich, various, reliable, and of great value. They relate to a grand subject, embraced in the discussions and inquiries concerning the constitution of the Solar System at least, if not of the universe. Independently of any views or theories respecting the actual origin of the Lights, and the phenomena observed by Mr. Jones, with such rare opportunities and diligence, we give it as our opinion that a full publication of the charts and observations will enrich physical science, and add to the lustre of the expedition, and the enduring worth of its history.

(Signed) B. SILLIMAN, SEN.,
[Emeritus Prof. of Chemistry, Geology, &c.]
JAMES D. DANA,
[Professor of Natural History.]
DENISON OLMSTED,
[Prof. of Nat. Philosophy and Astronomy.]
W. A. NORTON,
[Professor of Civil Engineering.]
EDWARD C. HERRICK,
[Librarian.]
ALEX. C. TWINING,
[Late Prof. Nat. Phil. and Math. in Middlebury College.]

Commodore M. C. PERRY,
Commander of the Japan Expedition.

UNITED STATES NAVAL ACADEMY,
Annapolis, Maryland, June 21, 1855.

MY DEAR SIR: What I have already seen of your remarks on the Zodiacal Light, makes me extremely desirous of seeing the whole. I hope all your observations will be published, with the utmost detail. We have heretofore had but few accurate observations on this Light. Vague and general descriptions, by different observers, at distant periods of time, without the aid of diagrams, except in very few instances, are all that we possess. The exact outline presented by the Light, from day to day, and its position in the heavens, as determined by the stars near which the outline passes, are obviously indispensable in prosecuting research on it. Your drawings (if published just as you made them on the spot, with the phenomena before you), will supply these desiderata, and astronomers will be put in a position to judge, as they might have done, had they enjoyed the same rare opportunities which you not only enjoyed, but so industriously improved. Not a single observation should be omitted, nor should any mere abstract be made in lieu of a complete publication. We want the *facts* just as they are, and as they will be shown by your faithful charts.

Whatever theories may be held with respect to this Light, the publication of your series of observations will be a most important contribution to science, if it will not, in fact, furnish the means of deciding one of the questions of astronomy heretofore most obscure.

Very respectfully, yours,

WILLIAM CHAUVENET,

[Prof. of Astronomy, &c., in the U. S. Naval Academy.]

Rev. GEORGE JONES, *United States Navy.*

Index of Times, Latitudes, &c.

No.	Date of observation.	Latitude.	Longitude.*	When taken.	Where taken.	Remarks.
	1853.	° ′	° ′			
1	April 2	10 32 N.	110 9 E.	Evening	At sea	
2	" 4	16 54	110 36	do	do	
3	" 5	18 51	111 46	do	do	
4	" 6	21 22	112 51	Morning	do	
5	" 7	22 18	114 10	Evening	Hong Kong, China	
6	" 8	22 18	114 10	do	do	do
7	" 9	22 18	114 10	do	do	do
8	" 26	22 11	113 36	do	Macao	
9	" 29	23 55	118 38	do	At sea	
10	June 7	26 10	127 42	do	Napa Kiang, Loo Choo	
11	" 8	26 10	127 42	do	do	do
12	" 11	26 10	127 42	Morning	do	do
13	" 15	26 10	127 42	do	do	do
14	" 23	26 10	127 42	Evening	do	do
15	" 24	26 10	127 42	do	do	do
16	" 25	26 10	127 42	do	do	do
17	" 27	26 10	127 42	do	do	do
18	" 29	26 10	127 42	do	do	do
19	" 30	26 10	127 42	do	do	do
20	July 1	26 10	127 42	do	do	do
21	" 2	26 10	------	do	At sea	
22	" 4	29 9	131 28	do	do	
23	" 5	29 36	132 5	Morning	do	
24	" 5	30 47	133 35	Evening	do	
25	" 6	31 8	134 31	Morning	do	
26	" 6	32 13	136 34	Evening	do	
27	" 7	32 36	137 26	Morning	do	Also East Zodiacal Light
28	" 7	33 50	138 53	Evening	do	[in the evening.
29	" 8	35 12	139 44	do	Off Uraga, Bay of Yedo, Japan	
30	" 9	35 12	139 44	Morning	do	do
31				Evening		
32	" 9	35 12	139 44	do	do	do East Zodiacal Light in
33	" 11	35 12	139 44	Morning	do	do [the evening.
34				Evening		
35	" 13	35 12	139 44	Morning	do	do
36	" 14	35 23	139 41	do	Upper Bay of Yedo	
37	" 15	35 23	139 41	do	do	do
38	" 16	35 23	139 41	do	do	do
39	" 18	33 42	138 13	do	At sea	
40	" 19	32 4	135 55	do	do	
41	August 4	21 45	121 33	Evening	do	
42	" 5	21 31	121 3	Morning	do	Also East Zodiacal Light
43	" 16	23 2	113 28	do	Blenheim Reach, Canton river	[in the evening.
44	" 17	23 2	113 28	do	do	do
45	" 26	23 2	113 28	Evening	do	do
46	" 29	23 2	113 28	do	do	do
47	" 31	23 2	113 28	do	do	do
48	Sept'r 1	23 2	113 28	do	do	do
49	" 2	23 2	113 28	Morning	do	do
50	" 3	23 2	113 28	do	do	do
51				Evening		
52	" 5	23 2	113 28	Morning	do	do
53	" 12	23 2	113 28	do	do	do
54	" 13	23 2	113 28	do	do	do
55	" 14	23 2	113 28	do	do	do
56	" 15	23 2	113 28	do	do	do
57	" 24	23 2	113 28	Evening	do	do
58	" 27	23 2	113 28	do	do	do
59	" 28	23 2	113 28	do	do	do
60	" 30	22 23	113 32	Morning	Cumsingmoon, China	
61				Evening		
62	October 1	22 23	113 32	Morning	do	do
63				Evening		
64	" 3	22 23	113 32	Morning	do	do
65				Evening		

* The longitudes, of course, can have no influence on the Zodiacal Light; but I have thought that it might interest the reader to know in what part of the globe the observations were made.

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No.	Date of observation.	Latitude.	Longitude.	When taken.	Where taken.	Remarks.
	1853.	° ′	° ′			
66	October 4	22 23 N.	113 32 E.	Morning	Cumsingmoon, China	
67	" 8	22 11	113 36	do	Macao	
68	" 18	22 11	113 36	Evening	do	
69	" 19	22 11	113 36	do	do	
70	" 20	22 11	113 36	do	do	
71	" 21	22 11	113 36	do	do	
329	" 21	22 11	113 36	do	do	Moon Zodiacal Light.
72	" 22	22 23	113 32	do	Cumsingmoon, China	
330	" 22	22 23	113 32	do	do	Moon Zodiacal Light.
73	" 27	22 23	113 32	do	do	
74	" 28	22 23	113 32	do	do	
75	" 29	22 23	113 32	Morning	do	
76				Evening	do	
77	" 31	22 23	113 32	Morning	do	
78				Evening	do	
79	Nov'r 1	22 23	113 32	Morning	do	
80				Evening	do	
81	" 2	22 23	113 32	Morning	do	
82	" 3	22 23	113 32	Evening	do	
83	" 4	22 23	113 32	do	do	
84	" 5	22 23	113 32	do	do	
85	" 8	22 23	113 32	Morning	do	
86	" 22	22 18	114 10	Evening	Hong Kong	
87	Dec'r 5	22 18	114 10	Morning	do	
88	" 21	23 4	113 26	Evening	Whampoa Reach, Canton river	
89	" 28	22 18	114 10	do	Hong Kong	
90	" 29	22 18	114 10	Morning	do	
91				Evening	do	
92	" 30	22 18	114 10	Morning	do	
93				Evening	do	
94	" 31	22 18	114 10	Morning	do	
	1854.					
95	January 2	22 18	114 10	do	do	
96				Evening	do	
97	" 3	22 18	114 10	Morning	do	
98				Evening	do	
99	" 4	22 18	114 10	Morning	do	
100	" 5	22 18	114 10	do	do	
101	" 6	22 18	114 10	do	do	
102	" 10	22 18	114 10	do	do	
103	" 11	22 18	114 10	do	do	
104	" 18	23 40	123 28	Evening	At sea	
105	" 24	26 10	127 42	do	Napa Kiang, Loo Choo	
106	" 25	26 10	127 42	do	do	
107	" 26	26 10	127 42	do	do	
108	" 27	26 10	127 42	Morning	do	
109				Evening	do	
110	" 30	26 10	127 42	Morning	do	
111				Evening	do	
112	" 31	26 10	127 42	Morning	do	
113	" 31	26 30	127 45	Evening	Inland	
114	Febr'y 1	26 30	127 45	Morning	do	
115	" 2	26 45	127 45	do	do	
116	" 4	26 33	127 54	do	do	
331	" 14	35 19	139 43	Evening	Bay of Yedo, Japan	Moon Zodiacal Light.
117	" 15	35 19	139 43	do	do	
332	" 15	35 19	139 43	do	do	Moon Zodiacal Light.
118	" 17	35 19	139 43	do	do	
333	" 17	35 19	139 43	do	do	Moon Zodiacal Light.
119	" 18	35 19	139 43	do	do	
334	" 18	35 19	139 43	do	do	Moon Zodiacal Light.
120	" 20	35 19	139 43	do	do	
121	" 21	35 19	139 43	do	do	
122	" 23	35 19	139 43	do	do	
123	" 24	35 25	139 41	do	do	
124	" 25	35 25	139 41	do	do	
125	March 6	35 26	139 42	do	Off Yokahama, Bay of Yedo	Joint sun and moon
126	" 7	35 26	139 42	Morning	do	
127	" 18	35 26	139 42	Evening	do	

INDEX—Continued.

No.	Date of observation.	Latitude.	Longitude.	When taken.	Where taken.	Remarks.
	1854.	° ′	° ′			
335	March 18	35 26 N.	139 42 E.	Evening	Off Yokahama, Bay of Yedo	Moon Zodiacal Light
128	" 20	35 26	139 42	do	do	
336	" 21	35 26	139 42	Morning	do	Moon Zodiacal Light
129	" 25	35 26	139 42	Evening	do	
130	" 27	35 26	139 42	Morning	do	
131				Evening		
132	" 28	35 26	139 42	Morning	do	
133				Evening		
134	" 29	35 26	139 42	Morning	do	
135				Evening		
136	" 30	35 26	139 42	do	do	
137	April 1	35 26	139 43	Morning	do	
138	" 17	35 19	139 43	Evening	do	
337	" 17	35 19	139 43	do	do	Moon Zodiacal Light
139	" 18	34 40	138 59	do	Harbor of Simoda, Japan	
140	" 20	34 40	138 59	do	do	
141	" 21	34 40	138 59	do	do	
142	" 22	34 40	138 59	Morning	do	
143	" 24	34 40	138 59	Evening	do	
144	" 25	34 40	138 59	do	do	
145	" 26	34 40	138 59	Morning	do	
146				Evening		
147	" 27	34 40	138 59	Morning	do	
148	" 28	34 40	138 59	Evening	do	
149	" 29	34 40	138 59	do	do	
150	May 6	34 40	138 59	Morning	do	
151	" 8	34 40	138 59	do	do	
152	" 15	40 13	142 52	Evening	At sea	
338	" 15	40 31	142 59	do	do	Moon Zodiacal Light
153	" 16	41 50	141 08	do	do	
154	" 17	41 49	140 47	do	Hakodadi, Japan	
155	" 19	41 49	140 47	do	do	
156	" 20	41 49	140 47	do	do	
157	" 22	41 49	140 47	Morning	do	
158				Evening		
159	" 23	41 49	140 47	Morning	do	
160	" 29	41 49	140 47	do	do	
161				Evening		
162	" 30	41 49	140 47	Morning	do	
163	June 2	41 49	140 47	do	do	
164	" 5	37 34	141 59	do	At sea	
165	" 8	34 40	138 59	do	Simoda, Japan	
166	" 21	34 40	138 59	Evening	do	
167	" 22	34 40	138 59	do	do	
168	" 24	34 40	138 59	do	do	
169	" 27	33 01	136 45	do	At sea, in the Macedonian	
170	" 29	30 26	136 52	Morning	do	do
171	" 29	28 33	136 21	Evening	do	do
172	" 30	28 22	138 18	Morning	do	do
173	July 1	27 35	136 08	do	do	do
174	" 4	28 51	132 00	do	do	do
175	" 5	29 50	130 49	do	do	do
176	" 6	29 18	129 37	do	do	do
177	" 7	28 56	127 52	do	do	do
178	" 8	29 14	126 26	do	do	do
179	" 13	25 09	121 46	Evening	Kelung, Island of Formosa	
180	" 14	25 09	121 46	do	do	do
339	" 14	25 09	121 46	do	do	Moon Zodiacal Light
181	" 15	25 09	121 46	do	do	do
182	" 18	25 09	121 46	do	do	do
183	" 19	25 09	121 46	do	do	do
184	" 20	25 09	121 46	do	do	do
185	" 21	25 09	121 46	do	do	do
186	" 22	25 09	121 46	do	do	do
187	" 24	25 39	121 37	Morning	At sea	
188	" 24	25 38	120 39	Evening	do	
189	" 25	25 31	120 41	Morning	do	
190	" 25	25 00	120 28	Evening	do	
191	" 26	24 24	120 04	Morning	do	

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No.	Date of observation.	Latitude.	Longitude.	When taken.	Where taken.	Remarks.
	1854.	° ′	° ′			
192	July 29	20 41 N.	114 54 E.	Morning	At sea	
193	" 31	19 29	116 22	do	do	
194	August 1	18 35	119 32	do	do	
195	" 4	17 48	116 31	do	do	
196	" 12	14 36	121 02	Evening	Manila	
197	" 17	14 19	120 40	do	At sea	
198	" 18	14 22	119 52	do	do	
199	" 21	14 27	117 16	Morning	do	
200	" 21	14 44	117 12	Evening	do	
201	" 22	14 46	117 11	Morning	do	
202	" 22	15 45	116 36	Evening	do	
203	" 23	16 00	116 26	Morning	do	
204	" 23	17 59	115 42	Evening	do	
205	" 24	18 36	115 26	Morning	do	
206	" 25	20 47	114 32	Evening	do	
207	" 26	21 00	114 18	Morning	do	
208	" 28	22 18	114 10	do	Hong Kong, China	
209	" 29	22 18	114 10	do	do	do
210	" 31	22 18	114 10	do	do	do
211	Sept'r 4	22 18	114 10	do	do	do
212	" 12	22 15	115 04	Evening	At sea, in the Mississippi	
340	" 12	22 14	115 18	do	do	do Moon Zodiacal Light
213	" 13	23 04	116 47	do	do	do
214	" 14	24 05	118 41	do	do	do
215	" 16	27 31	124 23	do	do	do
216	" 19	29 56	131 31	Morning	do	do
217	" 20	32 06	135 08	do	do	do
218	" 20	33 27	137 40	Evening	do	do
219	" 21	33 54	138 01	Morning	do	do
220	" 23	34 40	138 58	Evening	Simoda, Japan	
221	" 27	34 40	138 58	Morning	do	
222	" 28	34 40	138 58	do	do	
223	" 30	34 40	138 58	do	do	
224	Octo'r 11	35 24	165 16	Evening	At sea	
225	" 12	35 33	169 18	do	do	
226	" 14	33 46	175 52	do	do	
227	" 16	33 16	178 21 W.	do	do	
228	" 16	33 16	177 28	Morning	do	Duplicate day
229	" 16	33 01	174 49	Evening	do	
230	" 17	31 52	171 28	do	do	
231	" 18	30 41	167 45	do	do	
232	" 20	28 05	164 24	Morning	do	
233	" 21	25 58	161 58	do	do	
234	" 21	24 49	160 41	Evening	do	
235	" 23	21 18	157 55	do	Honolulu, Sandwich Islands	
236	" 25	21 18	157 55	Morning	do	do
237	" 30	21 18	157 55	do	do	do
238	Nov'r 1	21 18	157 55	do	do	do
239	" 11	23 52	152 34	Evening	At sea	
240	" 13	26 31	147 27	do	do	
241	" 20	36 17	126 51	Morning	do	
242	" 20	36 54	125 00	do	do	
243	" 21	37 16	123 33	do	do	
244	" 22	37 48	122 21	Evening	San Francisco, California	
245	" 25	38 02	122 07	Morning	Benicia	
246	" 27	38 02	122 07	do	do	
247	" 28	38 02	122 07	do	do	
248	" 29	38 02	122 07	do	do	
249	Dec'r 7	38 02	122 07	Evening	do	
250	" 8	38 02	122 07	do	do	
251	" 9	38 02	122 07	do	do	
252	" 11	38 02	122 07	do	do	
253	" 12	38 02	122 07	do	do	
254	" 13	37 48	122 21	do	San Francisco	
255	" 15	37 48	122 21	do	do	
256	" 16	37 21	122 45	do	At sea	
257	" 18	33 58	120 26	Morning	do	
258	" 18	31 43	120 03	Evening	do	
259	" 19	31 02	119 23	Morning	do	
260	" 19	29 39	117 20	Evening	do	

INDEX Continued.

No.	Date of observation.	Latitude.	Longitude.	When taken.	Where taken.	Remarks.
	1854.	° ′	° ′			
261	Dec'r 20	28 50 N.	116 43 W.	Morning	At sea	
262	" 20	26 51	115 27	Evening	do	
263	" 21	25 58	114 48	Morning	do	
264	" 22	23 16	112 20	do	do	
265	" 22	21 49	110 39	Evening	do	
266	" 25	17 21	103 17	Morning	do	
267	" 25	16 31	100 24	Evening	do	Joint sun and moon
268	" 26	15 59	100 24	Morning	do	
269	" 28	13 18	94 44	do	do	
270	" 29	11 38	92 03	do	do	
271	" 30	10 46	89 31	do	do	
	1855.					
272	Jann'y 1	7 27	85 39	do	do	
273	" 5	8 47	79 31	Evening	Taboga, Bay of Panama	
274	" 6	8 47	79 31	do	do	
275	" 8	8 47	79 31	do	do	
276	" 9	8 47	79 31	do	do	
277	" 10	8 47	79 31	do	do	
278	" 11	8 47	79 31	do	do	
279	" 12	7 07	79 26	do	At sea	
280	" 15	21	80 37	do	do	
281	" 17	2 54 S.	81 53	do	do	
282	" 18	3 40	82 20	Morning	do	
283	" 18	5 07	82 14	Evening	do	
284	" 19	5 57	81 52	Morning	do	
285	" 20	9 52	80 33	Evening	do	
286	" 22	12 46	79 28	Morning	do	
287	" 23	14 44	78 51	do	do	
288	" 30	29 07	72 49	do	do	
341	Feb'y 3	33 01	71 41	Evening	Valparaiso, Chili	Moon Zodiacal Light
289	" 6	33 01	71 41	do	do	
290	" 7	33 01	71 41	do	do	
291	" 8	33 01	71 41	do	do	
292	" 9	33 01	71 41	do	do	
293	" 12	35 41	73 59	do	At sea	
294	" 19	51 57	75 58	do	do	
295	" 21	53 38	70 53	do	Straits of Magellan	
296	" 22	53 38	70 53	Morning	do	
297	" 23	52 28	67 29	do	At sea	
298	" 28	40 51	57 21	do	do	
299	March 1	39 11	57 12	do	do	
300	" 13	22 55	43 06	Evening	Rio de Janeiro, Brazil	
301	" 15	22 55	43 06	do	do	do
302	" 16	22 55	43 06	Morning	do	do
303				Evening		
304	" 17	22 55	43 06	Morning	do	do
305				Evening		
306	" 20	22 55	43 06	Morning	do	do
307	" 21	22 55	43 06	do	do	do
308				Evening		
309	" 23	22 55	43 06	Morning	do	do
310	" 24	22 55	43 06	do	do	do
311	" 26	22 08	39 26	do	At sea	
312	" 28	19 32	36 13	do	do	
313	" 29	17 24	35 10	do	do	
314	April 4	1 37 N.	37 37	Evening	do	
315	" 9	11 12	45 51	do	do	
316	" 10	13 05	47 20	do	do	
317	" 11	15 09	48 56	do	do	
318	" 13	18 05	51 25	Morning	do	
319	" 13	20 09	53 19	Evening	do	
320	" 14	20 59	54 09	Morning	do	
321	" 14	22 31	55 16	Evening	do	
322	" 16	25 28	59 19	Morning	do	
323	" 16	27 04	61 35	Evening	do	
324	" 17	27 59	62 26	Morning	do	
325	" 18	30 30	65 39	do	do	
326	" 18	32 10	67 16	Evening	do	
327	" 19	33 12	68 16	Morning	do	
328	" 21	37 38	73 09	do	do	

Cassini's Observations.

No.	Date of observation	Latitude.	Longitude.	When taken.
	1685.	° ′	° ′	
342	Febru'y 27	48 51 N.	2 22 W.	Evening -----
343	March 22	48 51	2 22	----do-------
344	April 21	48 51	2 22	----do-------
345	Septem'r 9	48 51	2 22	Morning -----
346	" 27	48 51	2 22	----do-------
347	Novem'r 27	48 51	2 22	----do-------
348	Decem'r 4	48 51	2 22	----do-------
349	" 25	48 51	2 22	Evening -----
	1687.			
350	March 7	48 51	2 22	----do-------
351	October 15	48 51	2 22	Morning -----
352	Novem'r 14	48 51	2 22	----do-------

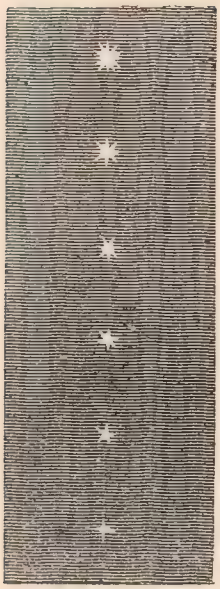
THE CHART.

When the publication of this work had been decided on, I tried, in company with a friend at the head of one of our observatories, a variety of other star-charts, to see how they would answer for the purpose; and we finally came to the conclusion that my original plan—that is, on Mercator's projection, with the ecliptic for the straight, or central, and guiding line—was the only eligible one. I determined, however, to construct the chart anew; and, for the purposes of greater correctness, procured from London an eighteen-inch globe by Maltby & Son, "manufactured and published under the superintendence of the 'Society for the Diffusion of Useful Knowledge';" and from this, but chiefly from the old globe, which I had so well proved, the present charts are constructed. In preparing such charts, I had no other resort than globes; for, with few slight exceptions, the published tables of the positions of stars give only their right ascensions and declinations; and to convert these, by calculations, into latitudes and longitudes, would have required more time than I could afford. This method of constructing the charts is sufficiently accurate for our purpose.

Indeed, I soon found that, in the publication of this work, where I had no choice of circumstances, any hope of perfect accuracy was not to be indulged; and I had to be satisfied with doing the best that I could. The charts were cut on wood; and its subsequent unequal shrinkage, together with shrinkage in stereotyping, must be the excuse for some defects in the plates, which the reader will discover, but which, I think, will not be found in any way to affect seriously the results. As to the lines, themselves, of the Zodiacal Light, I did not leave one of them to the risk of such mistakes as unfamiliarity with the subject might produce; but, after the plain stereotype plates had been prepared, I drew every line on them myself, the boundaries of the Zodiacal Light, horizons, zenith lines, &c.; and the engraver then following after, he has, I believe, given them with entire fidelity. I can thus assert that, for attaining accuracy, no pains-taking on my own part has been spared.

Any one, who attempts to construct a star-chart from published materials, will find many difficulties in his way. Of seven or eight of the best authorities to which I referred, as to the magnitudes of stars, no two were agreed; indeed, the discrepancies were so great, that the more I consulted, even standard authorities, the more embarrassed and uncertain I became; and I finally came back to my old 9-inch globe, which I had so long and thoroughly tested, and on the general accuracy of which I knew I could rely. In my charts, Bellatrix is, however, put down, by some inadvertence, as a star of the first, instead of the second magnitude; No. 8 Ceti has, from the same cause, a latitude less by 40″ than it ought to have. Doubtless there are many other defects in the charts, respecting which I can only say that I have done the best for accuracy that my circumstances would allow. I trust, however, that none will be found of sufficient importance to impair any one's confidence in the results here offered to the public. The *numbers* given to the stars, when such are adduced, are those which I found on the 9-inch globe.

THE LINES ON THE CHARTS, &c.



Represents the sun in its position at the time of observation.

Star of the first magnitude, 8 rays.

Star of the second magnitude, 7 rays.

Star of the third magnitude, 6 rays.

Star of the fourth magnitude, 5 rays.

Star of the fifth magnitude, 4 rays.

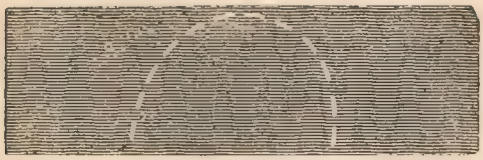
The central, straight line, up and down the page, is the *ecliptic* (consult chart No. 1), the guiding line in these charts. The scales of degrees, at the bottom and sides of the plate, are those of latitudes and longitudes.

The upward line, curving about the ecliptic, is the *equator*. (See also chart No. 1.)

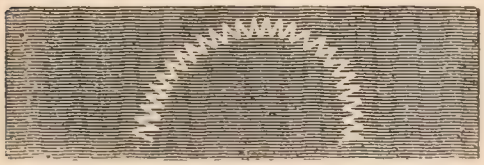
The lines across the plates, mostly towards the bottom of the plate, either full, or composed of full lines and dashes, represent the spectator's horizon at the times specified.

The line with dots, towards the top of the plate, shows the course of the spectator's zenith during the observations, his zenith point at each observation being noted. The object is to show his relative positions toward the ecliptic or plane of the nebulous ring, during this period. Where there is but one observation, his zenith is denoted by a dot with a circle around it; the time also being specified.

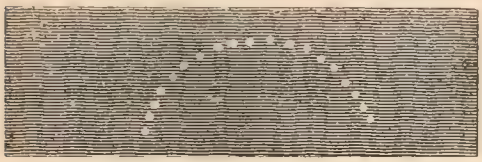
The *full lines* which pass upward on the chart, curve over and return again, are the boundaries of the *Stronger* Zodiacal Light, at the times noted with each. In some instances, the apex is omitted.



The *lines of dashes*, drawn in the same general course as the preceding, are the lines of a dimmer Light bordering the Stronger, as if from a more diffuse portion of the nebulous matter lying beyond the central or more condensed part. It is called, in my notes, the Diffuse Light.



On some of the charts are zigzag lines, showing the extent of a very effulgent light at the base of the Stronger Light. Its boundaries, at the upper part, were not very decidedly marked, yet sufficiently so to enable me to get them with a good degree of reliability.



Still beyond the Diffuse Light, there was, on some occasions, an appearance which seemed not to be exactly a positive light, but rather as if the sky was paled, or was a little less dark than beyond. The boundaries of this are noted by dotted lines. I consider this, however, only as from the outmost and most attenuated portion of the nebulous ring, now making itself visible, in consequence of the ring being brought more laterally to the eye than before. Such dots are also sometimes used at the apex of the lines for the Stronger Light, and mean, there, a light scarcely perceptible by the eye.

Lines of dashes and dots combined, represent the boundaries of the Zodiacal Light as showing itself deep in the night, from about 11 o'clock till 1. This Light was in appearance like the Diffuse Light in its dimmer aspects, but had lower and narrower boundaries; and I have chosen a distinct mark for it, in order to prevent the confusion which I found would arise on my charts, when the Diffuse Light itself appeared.

The full lines on the charts, with letters of the alphabet attached, are boundaries when the Stronger Light was subject to pulsations, or risings and sinkings of the Light, as noted on the opposite page.

When lines run into each other, as in No. 90 and *passim*, the common line must be considered as belonging to both observations, as far as the horizon will admit.

Sometimes the charts are too small to admit the zenith points, or the sun. In that case, their position is given in the annotations opposite.

In making out the horizon lines, &c., for Cassini's observations, I allowed, for the annual precession of the equinoxes, $50\frac{1}{4}''$, or $2^\circ\ 22'$ since 1685.

The reader will easily make out the N. and S. directions in these plates. In the evening observations, North is at his right hand; in the morning, at his left.

The time used in these annotations is, uniformly, *mean time*. I had to take my reckoning from the timepiece at the cabin door, which, especially in our rapid transitions E. or W., was sometimes in error by a few minutes. But this was of little consequence. The *relative* periods during the observations were of more importance, especially in noting the pulsations: and in these I was very particular: so that the relative periods may be fully depended upon.

OBSERVATIONS

ON THE

ZODIACAL LIGHT.

[It was my intention to have this series of published charts commence in June, 1853; but the singular sliding over of the Zodiacal Light, bodily, as the night advanced, and also its great inclination to the ecliptic, as shown in these observations in April, have induced me to take them from the rejected matter, and to give them insertion. The whole of May (being at the change of monsoons) was cloudy, and did not give me a single reliable observation.

From June 7th, the series goes on in unbroken order until our arrival at home.]

No. 1.

APRIL 2d, 1853: Evening.

Latitude 10° 32′ N.: Longitude 110° 9′ E.

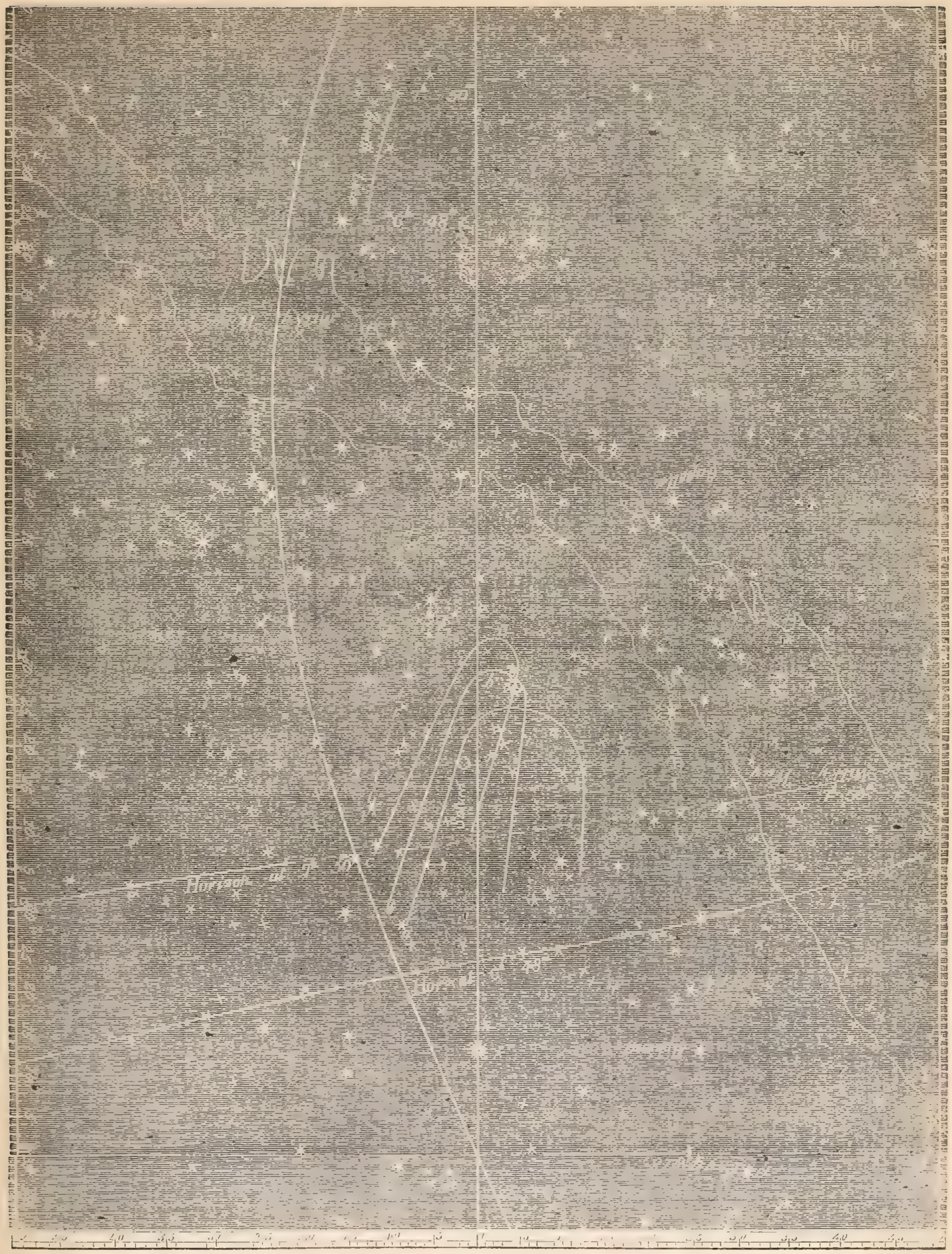
Sun set 6*h.* 7½*m.*

Stronger Light { 7*h.* 15*m.* / 7 50 } Diffuse Light probably* at 6*h.* 48*m.*

It is beginning to be difficult to get the northern boundary of the Diffuse Light, in consequence of its being so near the Milky Way. It is, however, I believe, correctly given in the chart. The horizon is now hazy almost every evening, and the Zodiacal Light cannot be made out for four or five degrees above its line.

In the early part of the evening, the boundary of the Stronger Light was as marked in the chart at *a a*. When I went out again, at $7^h\ 15^m$, the light appeared to have changed, bodily, over to the left, and was, as far as I could judge, after careful observation, at the boundary *b b;* by $7^h\ 50^m$ it seemed to have again changed, and it now appeared to be bounded by the line *c c*. I never before noticed any changes of this character.

* The exact time not noted in my records.


Aldebaran

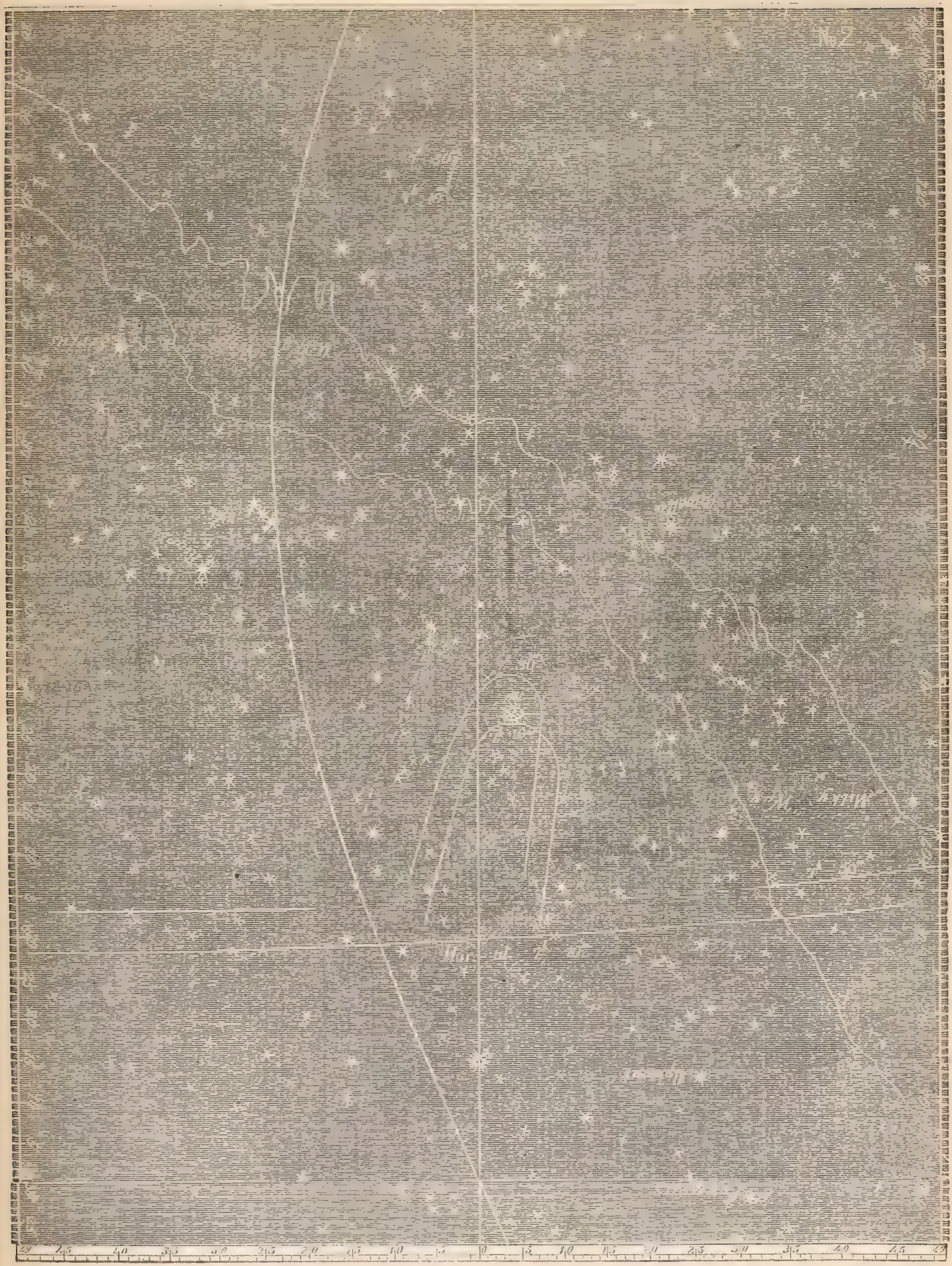
No. 2.

APRIL 4th, 1853 (3d was Sunday): Evening.

Lat. 16° 54′ N.: Lon. 110° 36′ E.
Sun set 6*h*. 10*m*.

Stronger Light { 7*h*. 10*m*. / 7 30 } Diffuse, probably at 7*h*. 10*m*.

The upper end of the Diffuse portion of the Zodiacal Light is now lost in the Milky Way; it is also so dim now, that I find great difficulty in getting its boundaries. I thought again this evening that, as time passed, the Stronger Light appeared to slide bodily over toward the south. I have given its boundaries as they seemed to be at the times specified in the chart.



No. 3.

APRIL 5th, 1853 : EVENING.

Lat. 18° 51′ N.: Lon. 111° 46′ E.

Sun set 6*h*. 11*m*.

Stronger Light	6*h*. 50*m*.	Diffuse, probably at 6*h*. 50*m*.
	7 15	
	7 30	
	7 45	
	8 0	

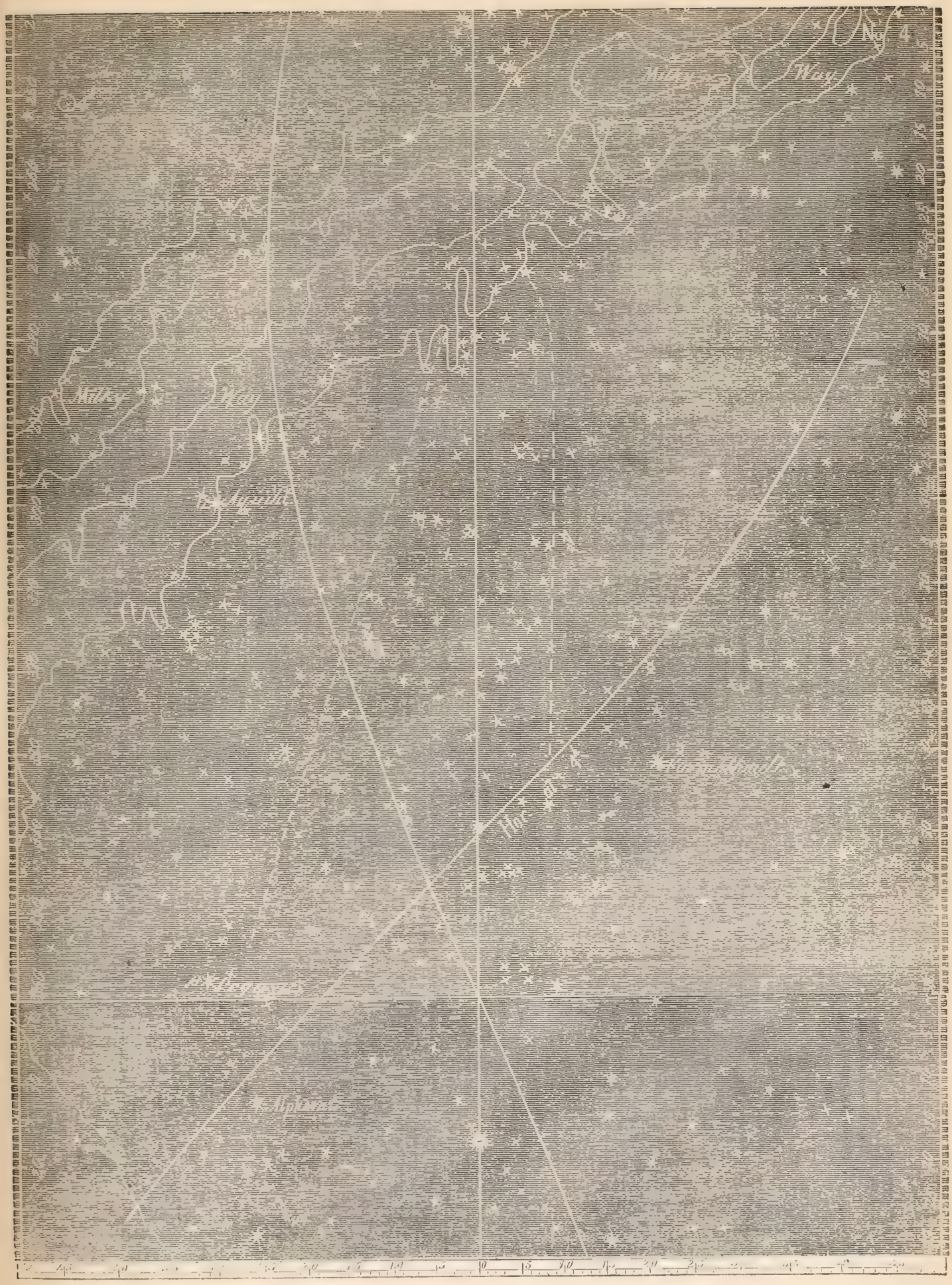
The evening was favorable for observations. The Zodiacal Light began to show itself soon after $6^h\ 39^m$. There *is now scarcely a doubt in my mind that the Stronger Light changes its place, bodily, during the evening.* At first, at $6^h\ 50^m$, it was bounded by the line *a a a*. When I went out again, to observe, at $7^h\ 15^m$, it had changed, and its boundary was at *b b b;* at $7^h\ 30^m$, it had brought its boundary to *c c c;* and at $7^h\ 45^m$, to *d d d*. At 8, it had got still further to the left, and was as given in the chart at *e e e*, its right border being about Saturn; but at this last observation the light was very dim. At 8 o'clock, and for some time previously, the Diffuse Light, over towards Algol, had faded entirely away.

No. 4.

APRIL 6th, 1853: Morning.

Lat 21° 22′ N.: Lon. 112° 57′ E.
Sun rose 5*h*. 52*m*.
Diffuse Light at 4 o'clock.

Rose early. The Zodiacal Light already to be seen at $3^h\ 10^m$, but was near the horizon. At 4^h, it was high enough to give a distinct outline; but I was baffled by numerous flitting cirri, and could not get boundaries of the Stronger Light. That given, I believe may be fully depended on.



No. 5.

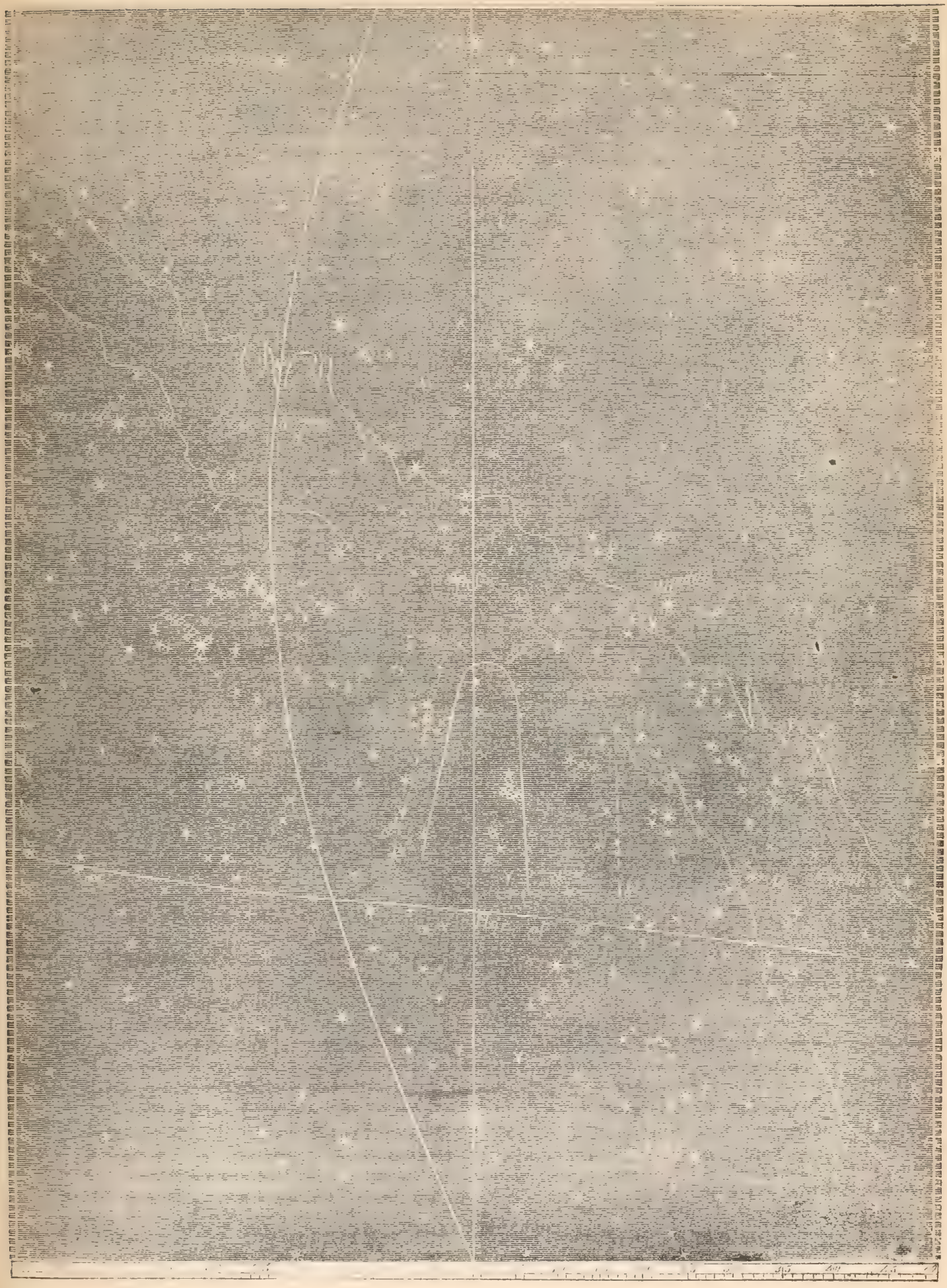
APRIL 7th, 1853: EVENING.

Lat. 22° 18′ N. Lon. 114° 10′ E.

Sun set 6h. 13m.

Stronger and Diffuse Light at 8 o'clock.

Last evening cloudy; so also this morning. This evening I was prevented from observing till 8 o'clock. At that time, the Zodiacal Light was partly obscured by a cloud; but I was able to get its outline. I thought, at one time, that the Diffuse Light crossed the Milky Way, and made itself perceptible above—as high up as Castor and Pollux; but on calling a quartermaster to look also, he could not make it out higher than the Milky Way; so I let it pass.



No. 6.

APRIL 8th, 1853: EVENING.

Lat. 22° 18′ N.: Lon. 114° 10′ E.
Sun set 6*h.* 14*m.*
Stronger Light { 7*h.* 30*m.* / 8 0 } Diffuse, 8*h.*

Clouds in the morning. This evening was cloudless, but rather hazy, and the observation was not entirely satisfactory. I have put down the Light as it appeared to me; but I cannot offer these lines as fully reliable.

No. 7.

APRIL 9th, 1853: Evening.

Lat. 22° 18′ N.: Lon. 114° 10′ E

Sun set 6*h.* 14*m.*

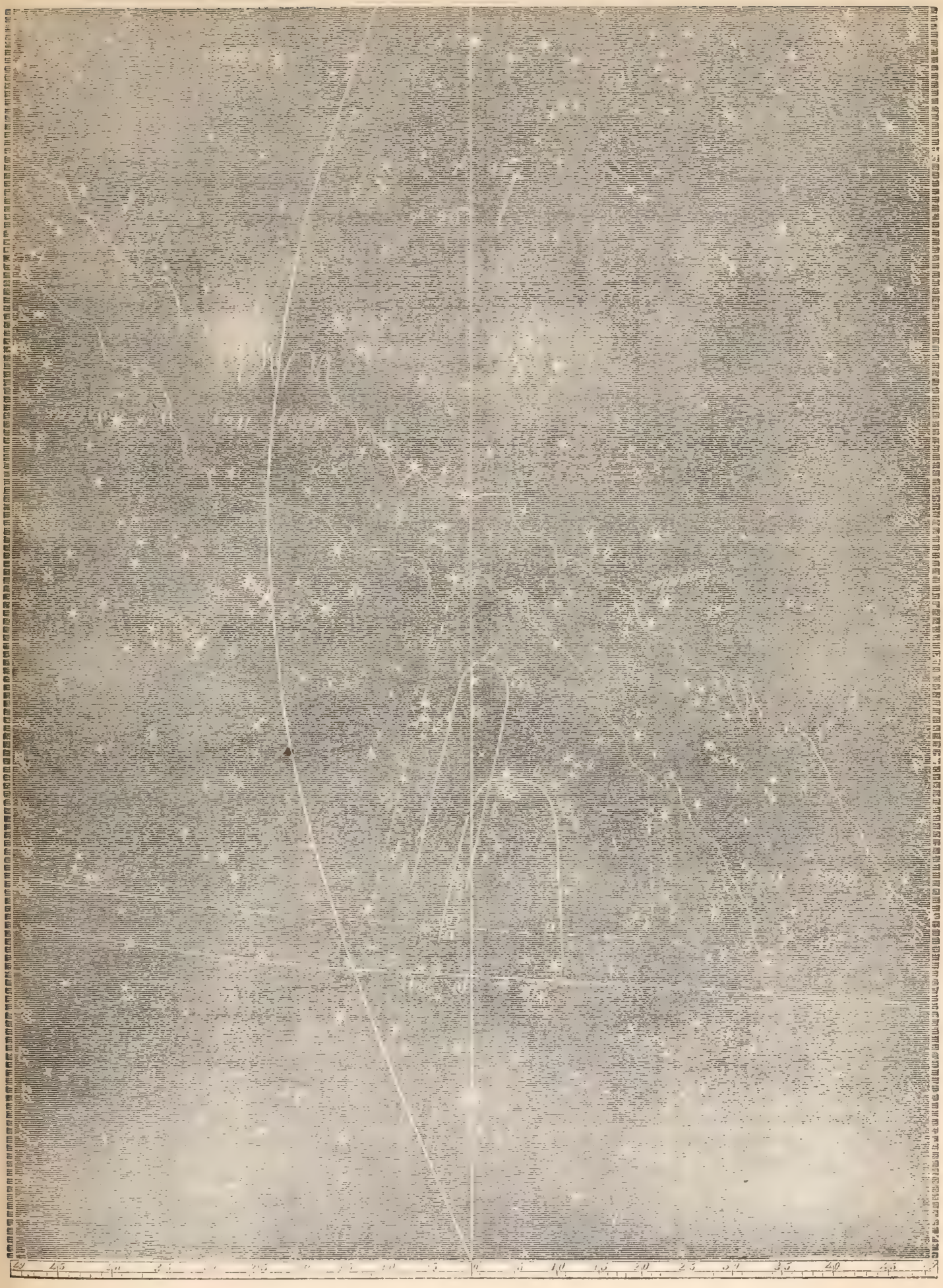
Stronger Light { 7*h.* 20*m* / 7 45 } Diffuse, 7*h.* 15*m*

Clouds in the morning. This evening, just along the horizon, hazy; but otherwise a good night for observation. In the early part of the evening, the outlines of the Stronger Light were at *a a a;* the Diffuse is marked also on the chart. Wishing to make this evening's observation a particularly careful one, on account of this singular sliding over of the light, I called two of the quartermasters,* separately, and asked them to tell me where the Stronger Light was, without putting any leading questions to them, or telling them my object. The first replied: "It is considerably brighter to the right of that star (Saturn) than it is to the left; that star is its left-hand limit. * * * Oh! yes, sir, the principal part is on the right of it," (Saturn). The other, to my question where the brightest part was, replied: "Well, I fancy it's to the right of that star (Saturn). Yes; that's the brightest place, right under that group of stars, (Pleiades,) and to the right of that star" (Saturn). This was at $7^h\ 20^m$. At $7^h\ 45^m$ I called them again, and also Dr. ———, and asked them separately. Dr. ——— described the outlines in the sky, and I drew them on the chart at *b b b* by his description. The two quartermasters gave the same boundary. It corresponded also to my own views of the case.

I think all these outlines may be fully relied on. I notice, also, that, as the evening advances, the Diffuse Light on the right of α Arietis, and so up, entirely disappears. I have thought so for several evenings; this evening it was decidedly so.

[Brooklyn, May 26, 1856. These lateral changes of the whole body of the Stronger Zodiacal Light are very remarkable. I cannot see any room for mistake; as there might have been, had the Light been more inclined to the horizon. But the horizon and ecliptic made nearly a right angle. My own change of place, as respects the ecliptic, during the interval of observations, does not meet the case. The great inclination of the Light to the ecliptic is also noteworthy. This latter circumstance appears also in the observations of March 30th and 31st, 1853; on which occasions, however, I noted only the Diffuse Light.]

* It may be well to say to landsmen, that quartermasters are among the highest petty officers in our ships. They are taken from the oldest and most reliable among the seamen. In port, one, and at sea, two, of them must always be on deck, day and night, on watch or other duty.



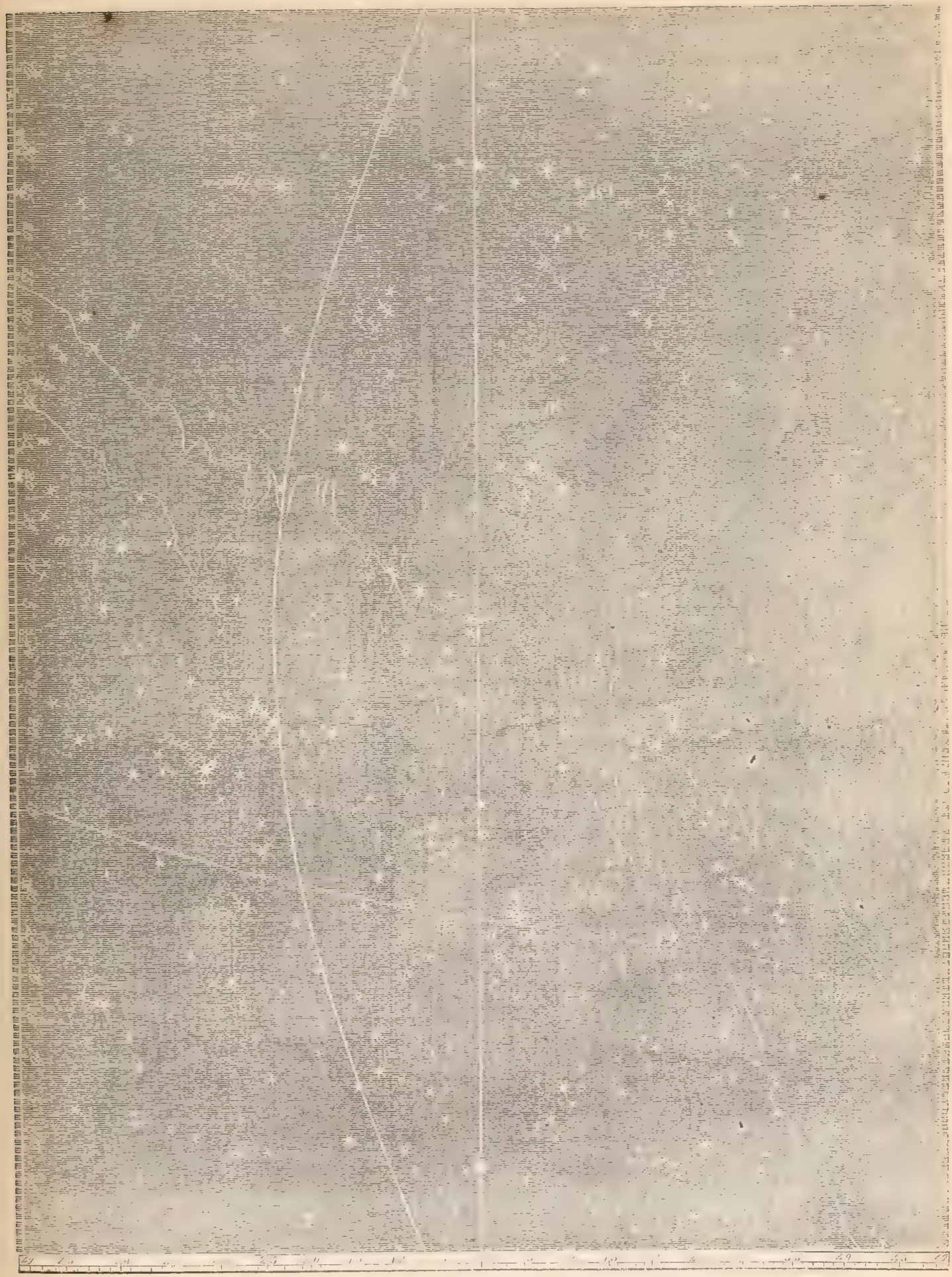
No. 8.

APRIL 26th, 1853 : Evening.

Lat. 22° 11′ N. : Lon. 113° 36′ E.
Sun set 6*h*. 22*m*.
Diffuse Light at 8*h*.

We have much cloudy weather now, owing to the change of monsoons. Had an observation on the evening of the 11th, but the Zodiacal Light was so faint that I have not thought it best to give a distinct chart for it. The moon also interfered that evening till at $8^h\ 10^m$, when it got into a fog-bank near the horizon; at that hour, though the Zodiacal Light was dim, I could see that the boundaries of the stronger portion were, as on the preceding evenings; the left-hand boundary being at Aldebaran, and the right, grazing the southern portion of the Pleiades. At $8^h\ 30^m$ the Light could scarcely be made out at all; and I could not, at any time, get the boundaries of the Diffuse Light.

From the 11th till this evening, cloudy weather. To-night I was continually troubled by flying clouds, but the boundaries of the Diffuse Light were tolerably distinct. After 8 o'clock, nothing could be had reliably.

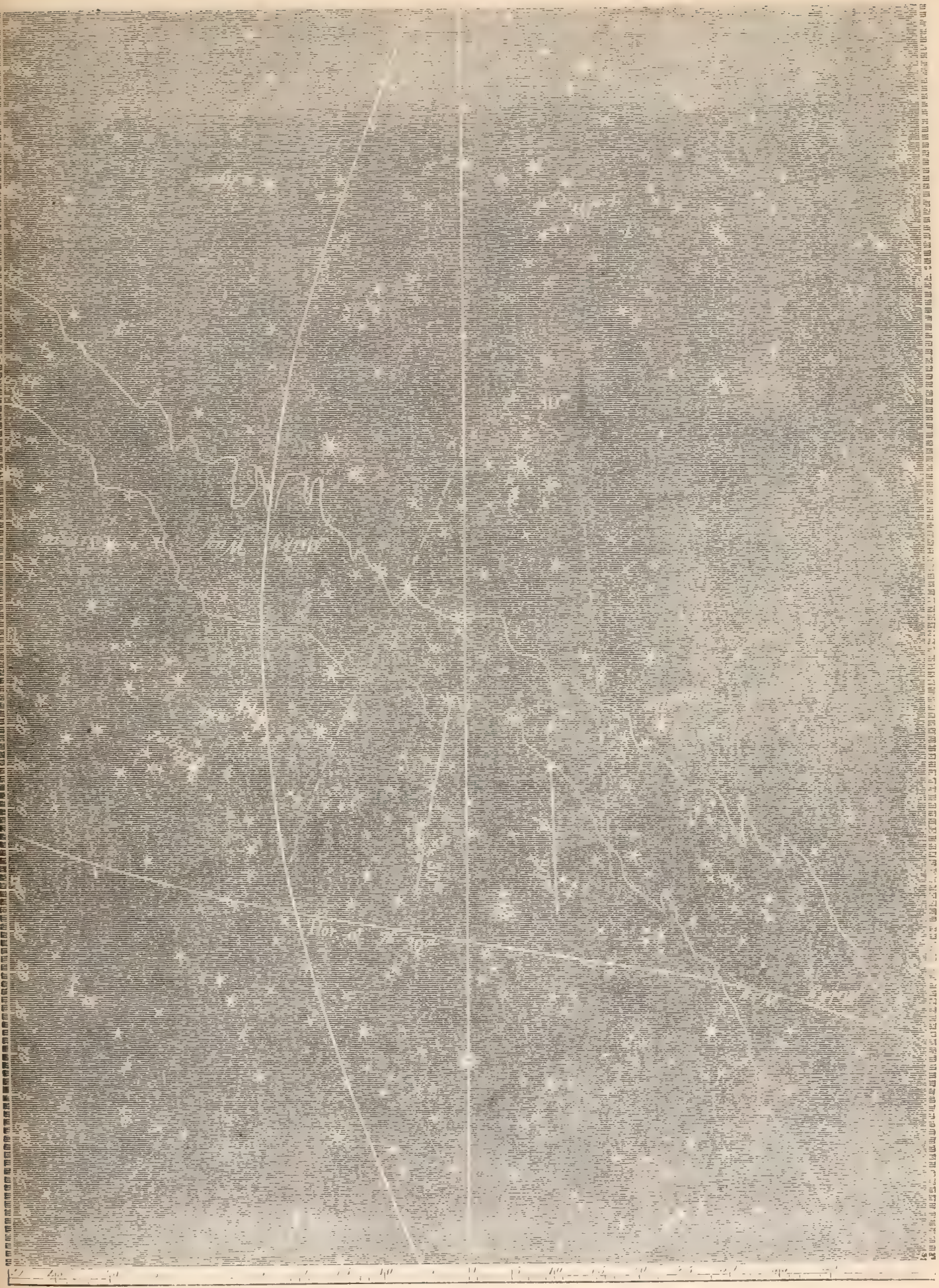


No. 9.

APRIL 29th, 1853: Evening.

Lat. 23° 55′ N.: Lon. 118° 38′ E.
Sun set 6*h*. 23*m*.
Stronger and Diffuse Light at 7*h*. 30*m*.

Cloudy weather since last date till this evening, when the sky was quite clear, allowing me to have a good observation. I could not observe, this evening, that the Stronger Light changed to the left, as previously noted; but if this is the fact, the Milky Way would make it difficult to be observed. At $8^h\ 30^m$, the Light was still visible, but was too dim to give outlines.



No. 10.

JUNE 7th, 1853 : Evening.

Lat. 26° 10′ N : Lon. 127° 42′ E
Sun set 6*h.* 16½*m.*
Stronger and Diffuse Light at 8*h.* 20*m.*

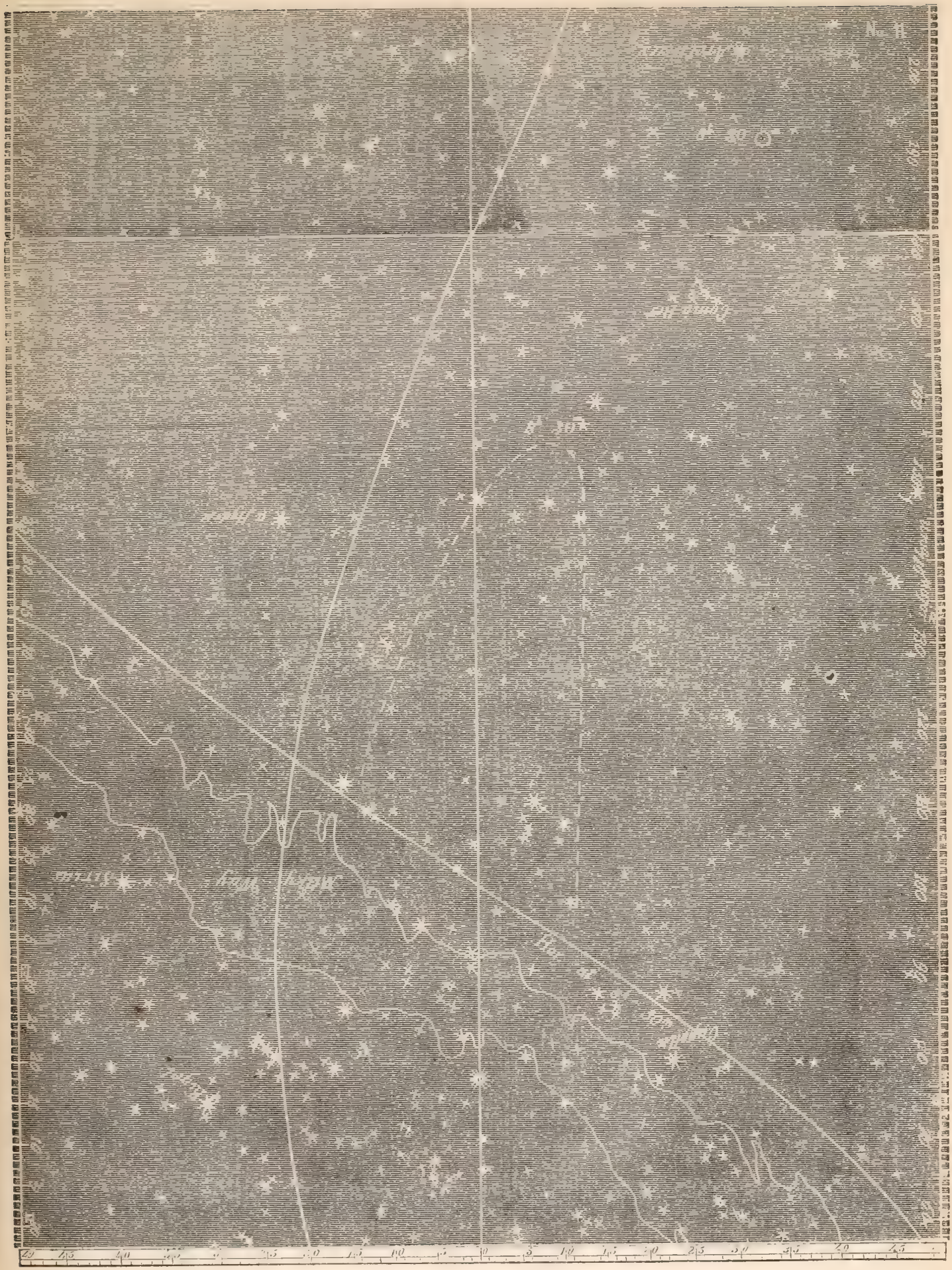
Since April 29th, clouds or the moon interfered uniformly till last evening, which was on Sunday. This evening had a very clear sky, and I observed carefully; but I found it difficult to get boundaries, as they do not now have their usual distinctness in the sky.

No. 11.

JUNE 8th, 1853. EVENING.

Lat. 26° 10′ N., Lon. 127° 42′ E.
Sun set 6*h*. 47*m*
Diffuse Light at 8*h*. 30*m*

Had a view of Zodiacal Light, but a brief one; for clouds soon intervened, and so remained.

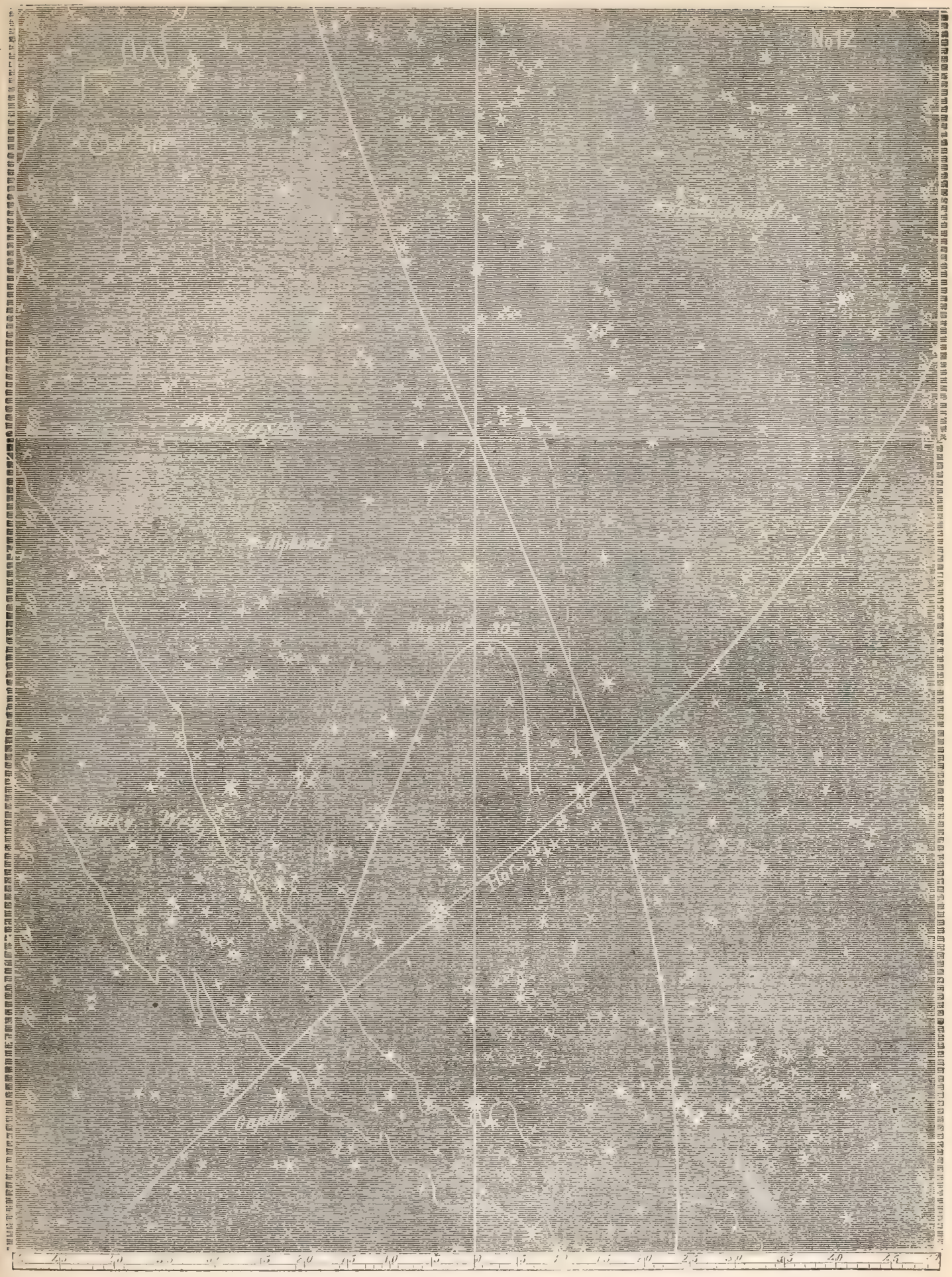


No. 12.

JUNE 11th, 1853 : MORNING.

Lat. 26° 10′ N. : Lon. 127° 42′ E.
Sun rose at 5*h*. 11*m*.
Stronger and Diffuse Light, [time not recorded, but probably at 3*h*. 30*m*.]

Clouds last evening. This morning I found the Milky Way interfering with the northern termination, but had a fair observation.


No 12
Aquila

No. 13.

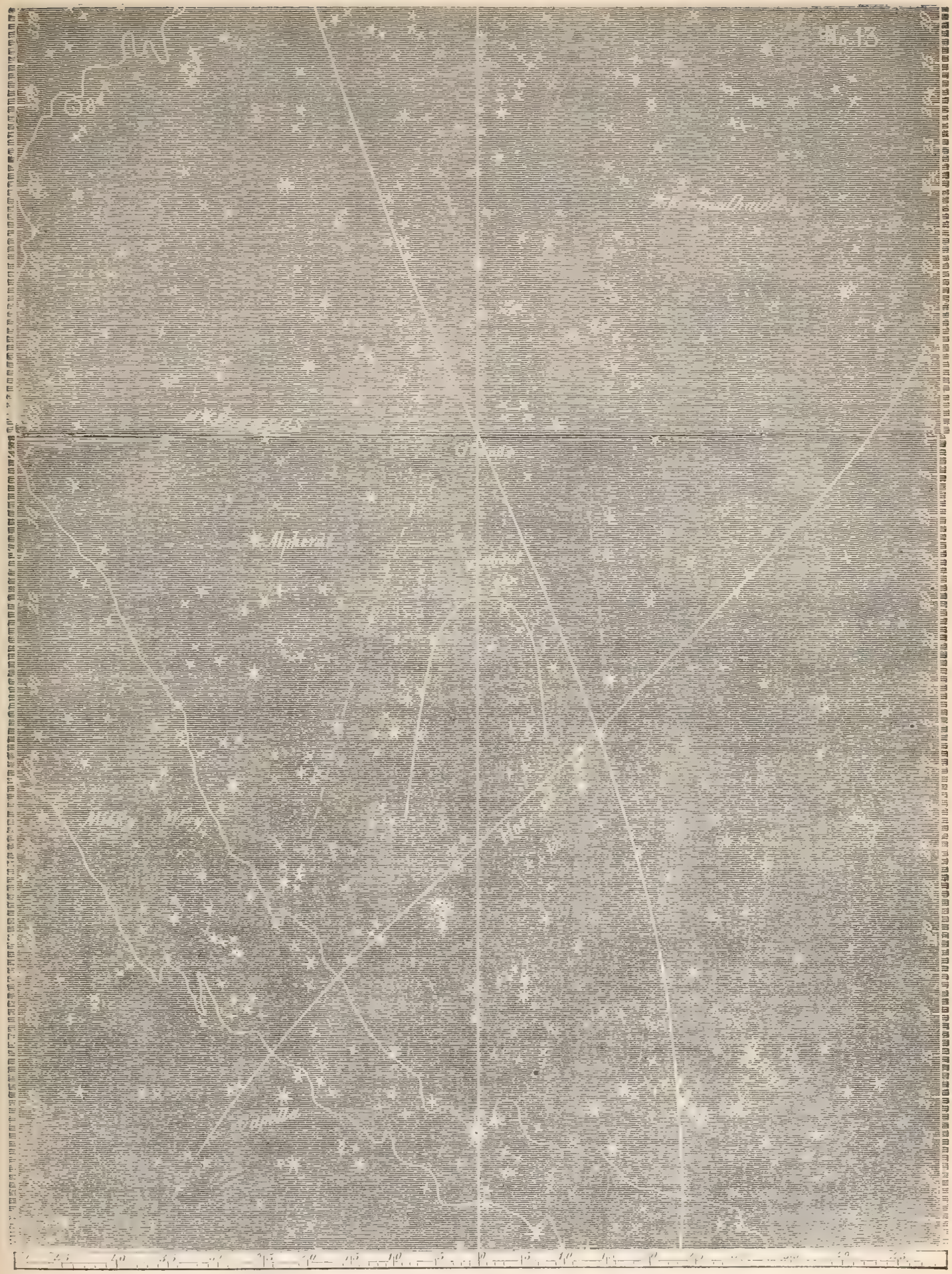
JUNE 15th, 1853: Morning.

Lat. 26° 10′ N.: Lon. 127° 42′ E.

Sun rose 5*h*. 12*m*.

Stronger and Diffuse Light [probably at 3 o'clock].

Rose at $2^h\ 30^m$. The view was not very satisfactory, owing to the strong inclination of the ecliptic to the horizon Saw a remarkable falling star. It moved with about half the swiftness usual with such bodies; had a long tail, say about 5° in length, and looked exactly like a comet. Its motion was in the line of a great circle. By and by, the star or nucleus exploded and formed into three bright specks, strung lengthwise in a line with its motion and tail. Then, after a little while all disappeared together.

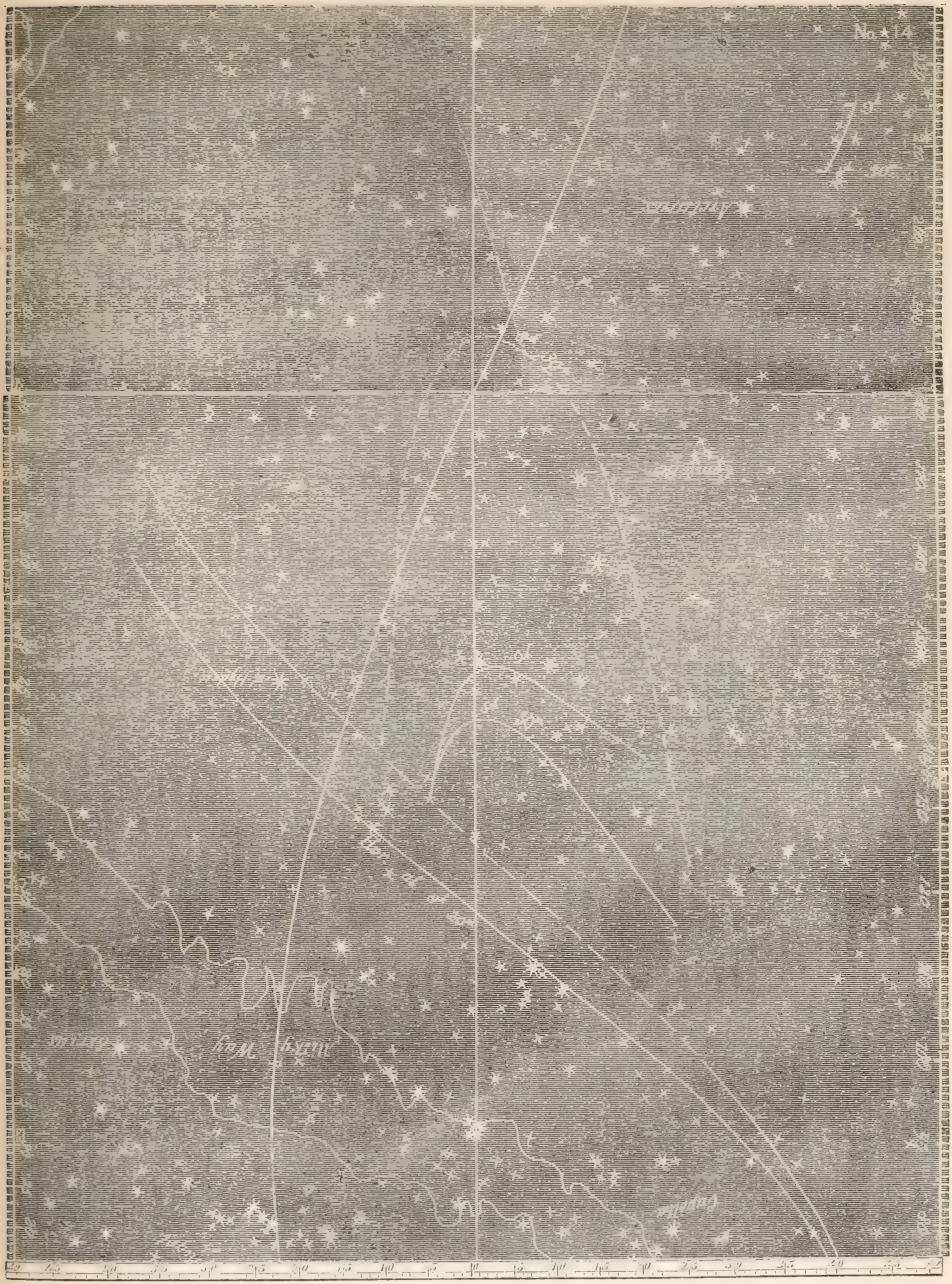

Aldebaran
Algol
Capella
Rigel
Procyon
Sirius
Betelgeux
Castor
Pollux
Regulus
Spica
Arcturus
Antares
Vega
Deneb
Altair
Fomalhaut

No. 14.

JUNE 23d, 1853 : Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.
Sun set at 6*h*. 50½*m*.
Stronger Light at 8*h*. 30*m*. and 9*h*. Diffuse at 8*h*. 30*m*.

Am carefully on the lookout for the Zodiacal Light, but clouds and the moon have interfered. This evening, got a view, and found the light had apparently some new characteristics. The twilight is long, and it is not till $8^h\,30^m$ that I can make out the outlines. The Stronger Light, at $8^h\,30^m$, seemed to stretch away to the northward, so as to reach 70° along the horizon. Its right extremity, however, had the look of a hard sky, not the gauzy appearance of the Zodiacal Light. It was very distinct. At 9^h the Stronger Light had ascended, extending, however, as before, 70° along the horizon. The Diffuse Light is very faint, and can be recognized only by the dimming of the stars behind it: it required a great many trials in order to get its boundaries.


No. 14

No. 15.

JUNE 24th, 1853: EVENING.

Lat. 26° 10′ N.: Lon. 127° 12′ E.

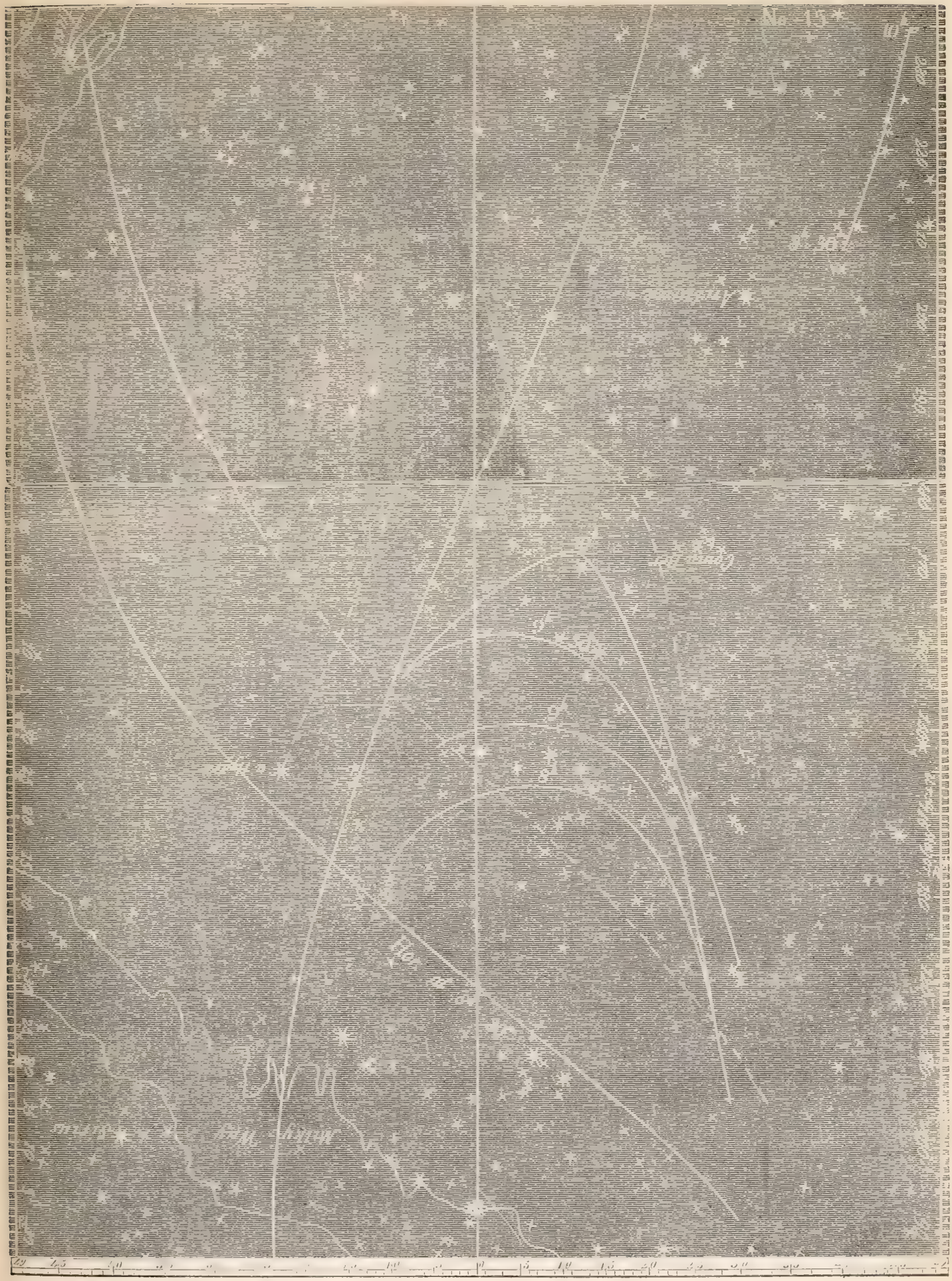
Sun set 6*h*. 51*m*.

Stronger Light at 8*h*. 30*m*. Diffuse at 8*h*. 30*m*.

9	0
9	30
10	0

Had a good view of the Zodiacal Light, and have given its boundaries in the chart. At 10 o'clock, the Stronger Light extended upward in an unusual manner; I have copied its boundaries as they appeared to me. The Diffuse Light can now scarcely be made out.

It is possible that my watching the eastern and western portions of the sky more intently than the rest gives me the impression that there are more falling stars in those directions than in any other; but so it seems to me.



No. 16.

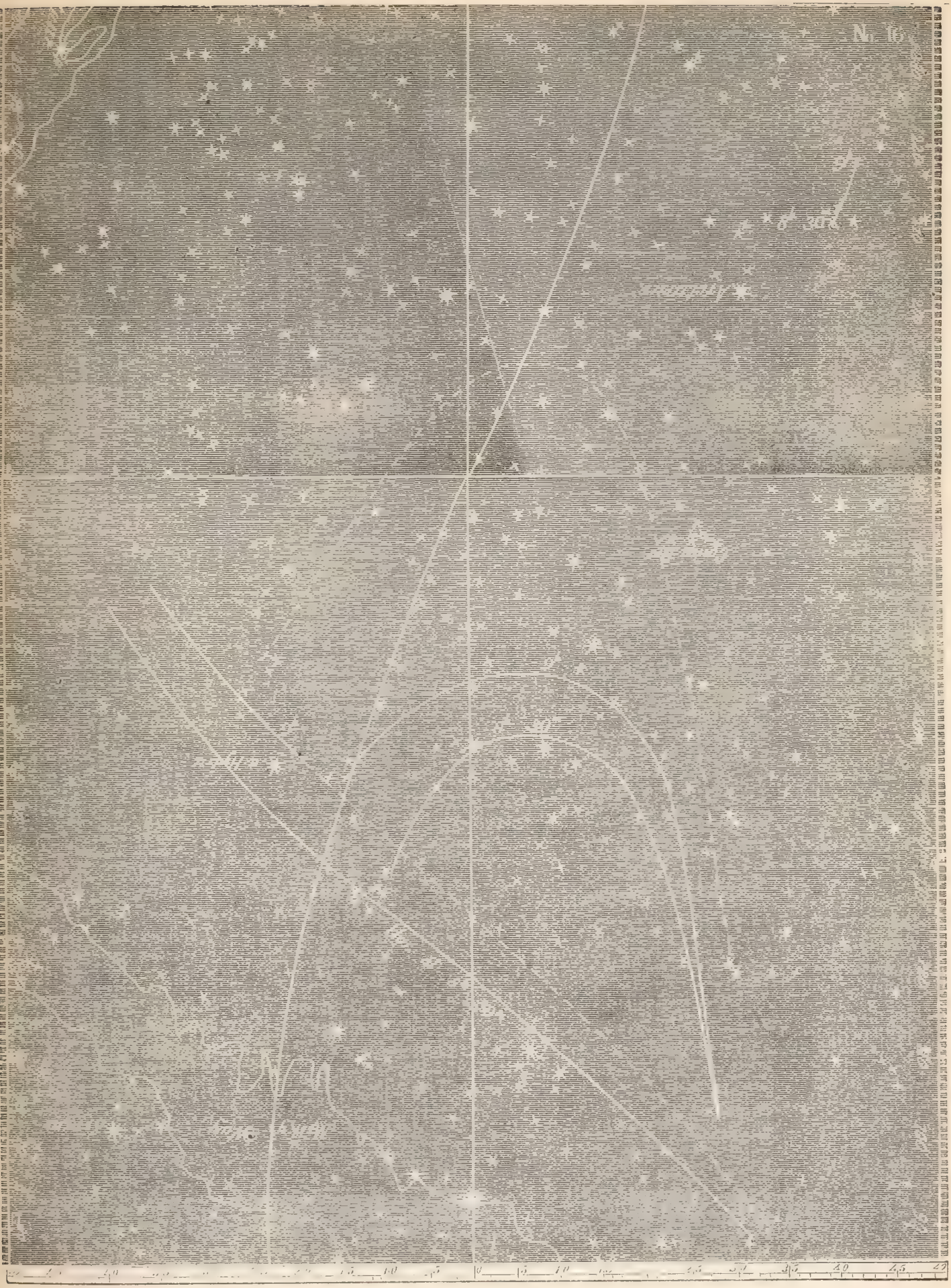
JUNE 25th, 1853 : Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.

Sun set 6*h*. 51*m*.

Stronger Light at 8*h*. 30*m*. and 9*h*. Diffuse [time not recorded.]

Had a very good observation. At 10 o'clock the Zodiacal Light was still very distinct.

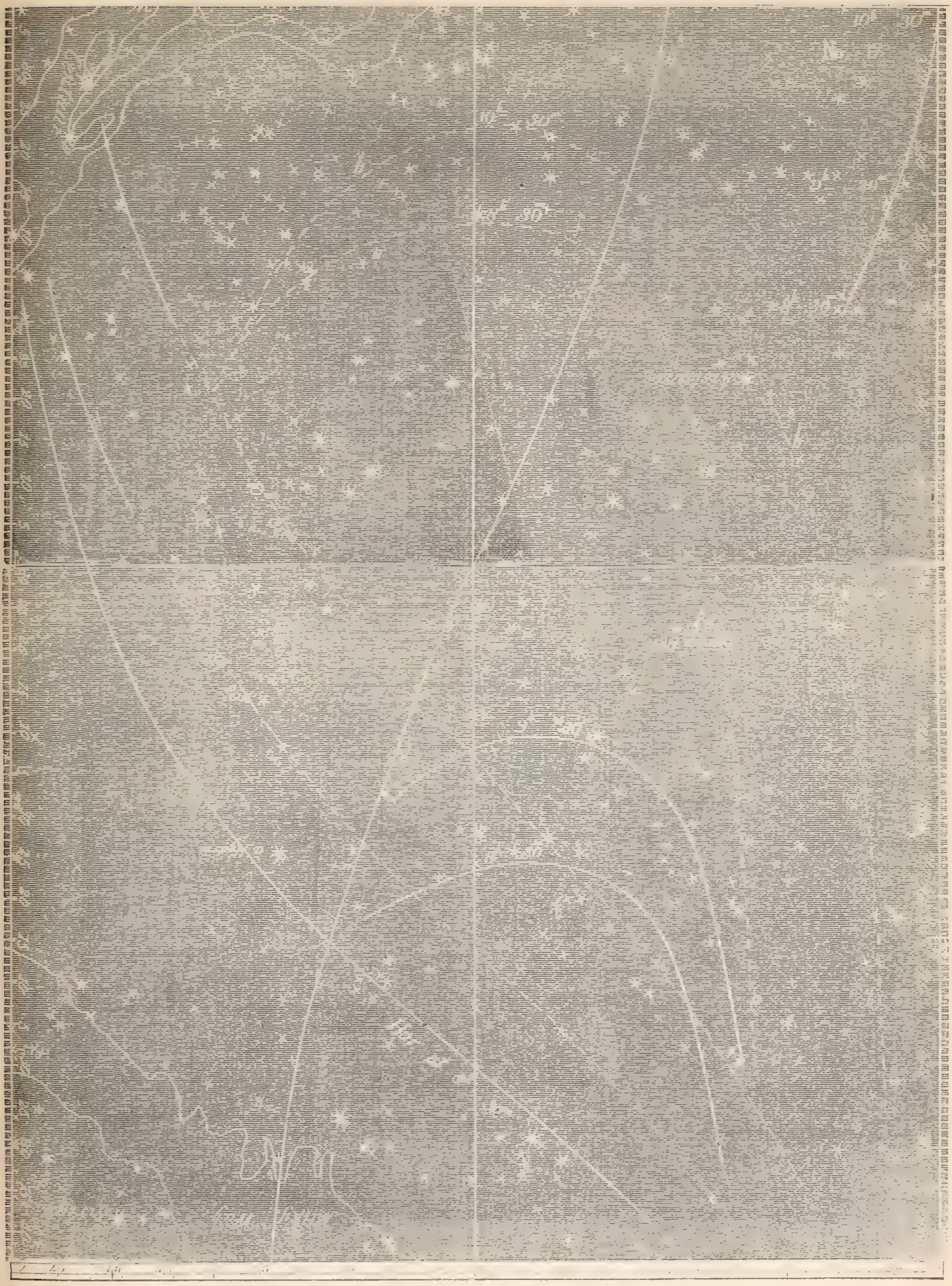


No. 17.

JUNE 27th, 1853, (Monday) : EVENING.

Lat. 26° 10′ N.: Lon. 127° 42′ E.
Sun set 6*h*. 51½*m*.
Stronger and Diffuse Light at 8*h*. 30*m*. and 10*h*. 30*m*.
Sun's Longitude, 95° 39′.

I suspected, from some glances at the Zodiacal Light, last evening, that I was giving it a too contracted boundary; and, this evening, determined on a very careful observation, as the evening was very fine, atmosphere very clear, and the sky unusually brilliant. After looking carefully myself, I called one of the oldest of the quartermasters, and, drawing his attention to the light, I said: "You observe that, over there (pointing to the northward), the sky is bluer and darker." He said "Yes." "You observe also, that up here (along the ecliptic), the stars are not so bright as in the parts you have just been looking at." To this he also assented. "Now I want you to point out, in the sky, the boundary between these two appearances; where the stars begin to lose their brightness, and the sky begins to be less blue." He soon commenced drawing the boundaries, which corresponded exactly with those which I myself had just mentally been giving it, and which are marked in the chart by the line of $8^h\ 30^m$ *a a a*. At $10^h\ 30^m$ it had extended as shown in the chart at *b b b*. At $8^h\ 30^m$ the full extent of the Stronger Light along the horizon was 75°. At $10^h\ 30^m$ the limits of the Stronger Light were not so well defined; the light was stronger between the horizon and 48 of Ursa Major, Coma Ber., and 5 Virginis, than it was above.



No. 18.

JUNE 29th, 1853: EVENING.

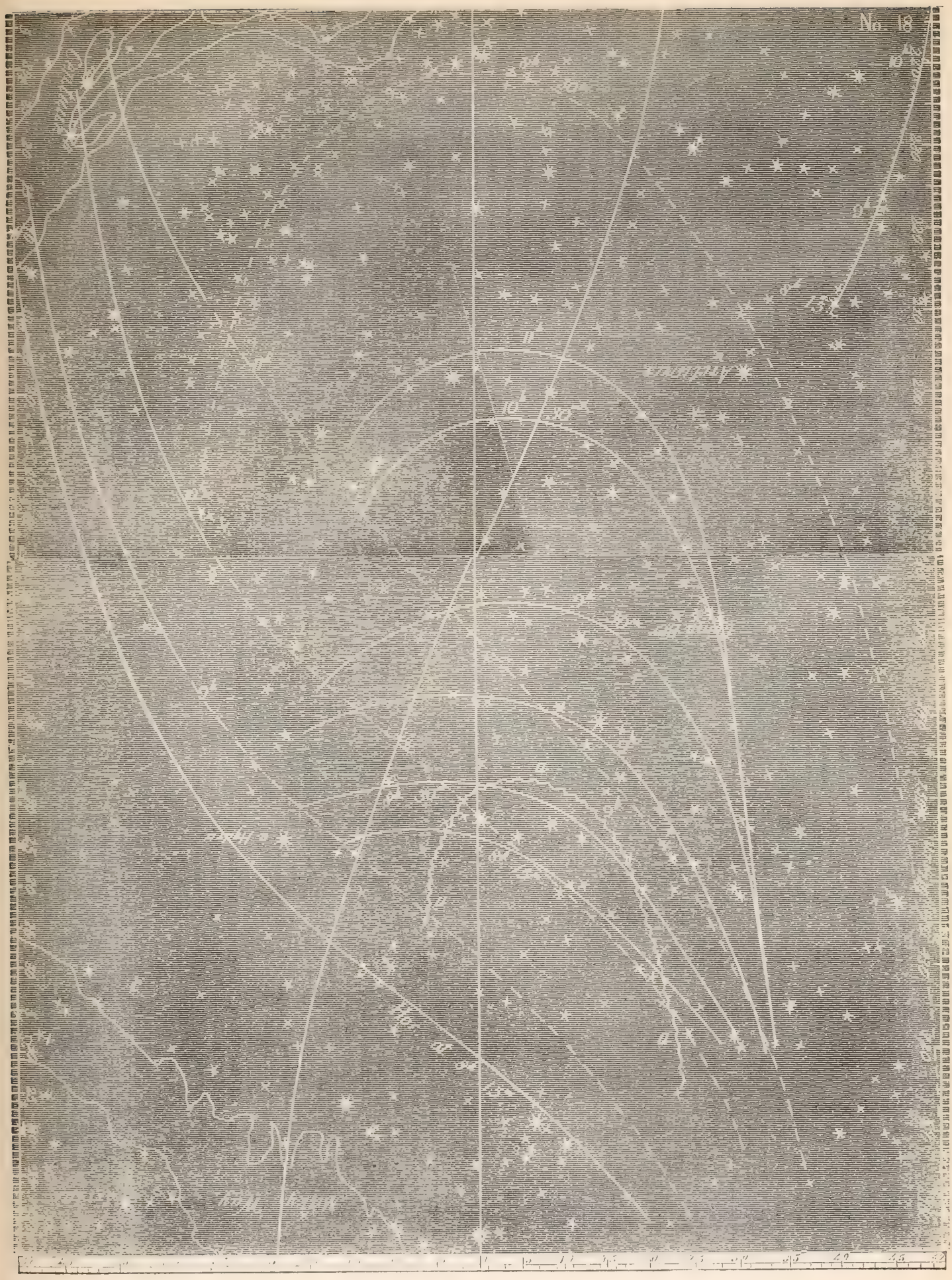
Lat. 26° 10′ N.: Lon. 127° 42′ E.

Sun set 6*h*. 51½*m*.

Stronger Light at 8*h*. 15*m*. Diffuse at 8*h*. 30*m*.

8	30	
9	0	
9	30	
10	0	Intense Light at 9*h*.
11	0	

Had a very good observation; sky very clear. Got two of the quartermasters, at $8^h\ 30^m$, to draw the limits of the Diffuse Light; they both agreed, and their ideas corresponded with my own: these limits are given in the chart; but the light defined was very dim, only a less depth of color in the sky, and an inferior brightness of the stars. At 9^h there was, within the Stronger Light, a more effulgent portion, which is bounded by the zigzag line *a a a*. At $11^h\ 30^m$, the ecliptic had sunk so near to the horizon that I could not get any boundaries, and the light seemed to have nearly died away. At $10^h\ 30^m$ it was faint.

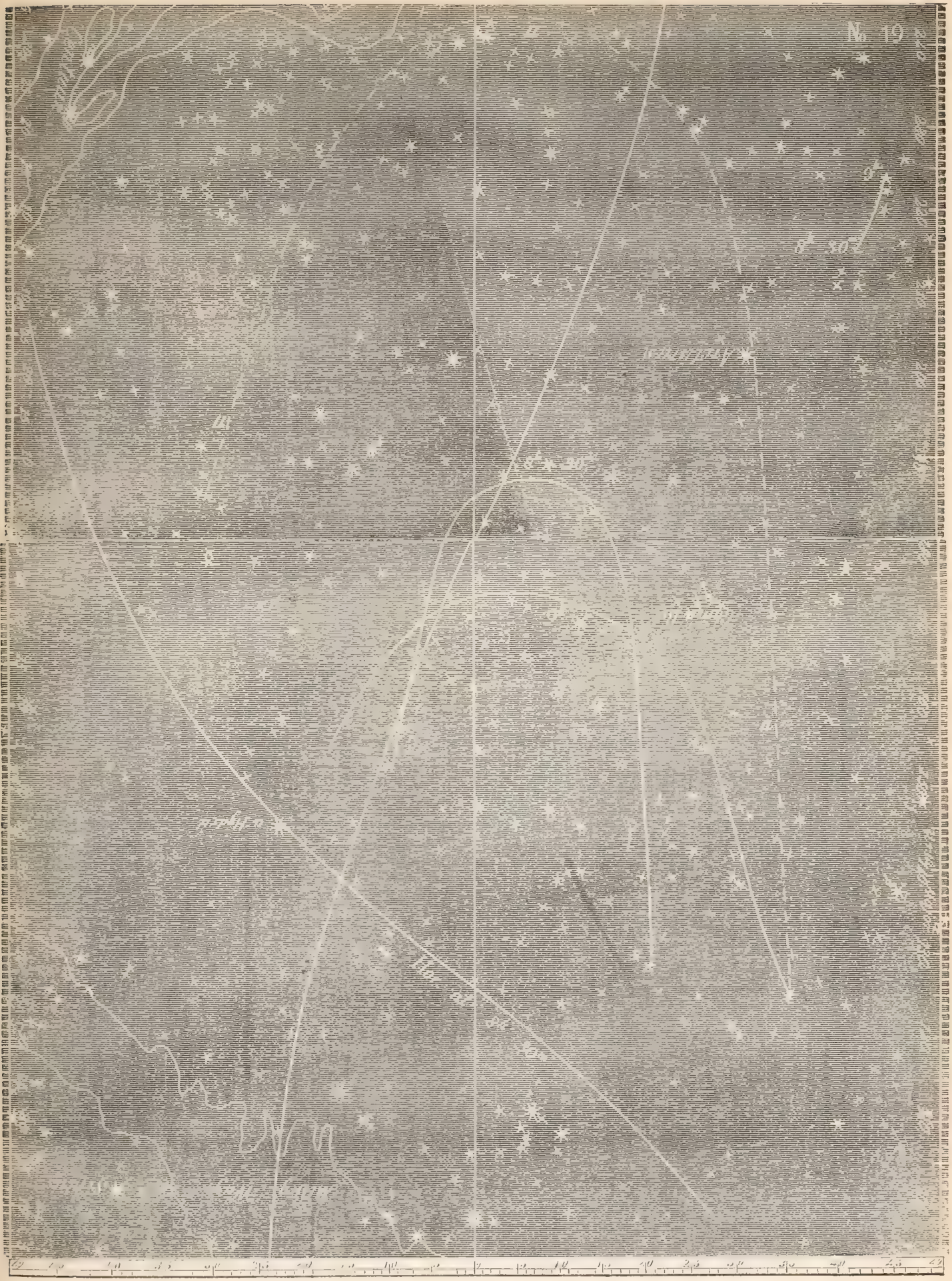

No. 6

No. 19.

JUNE 30th, 1853 : Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.
Sun set 6*h*. 51*m*.
Stronger Light at 8*h*. 30*m*. and 9*h*. Diffuse at 8*h*. 30*m*.

At $8^h\ 30^m$ the Stronger Light seemed to extend upward more than usual; but I was suspicious of it, the evening not being very favorable. At 9^h it had its usual shape. The boundary of the Diffuse Light, as before.


No. 19

No. 20.

JULY 1st, 1853 : Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.

Sun set at 6*h*. 51½*m*.

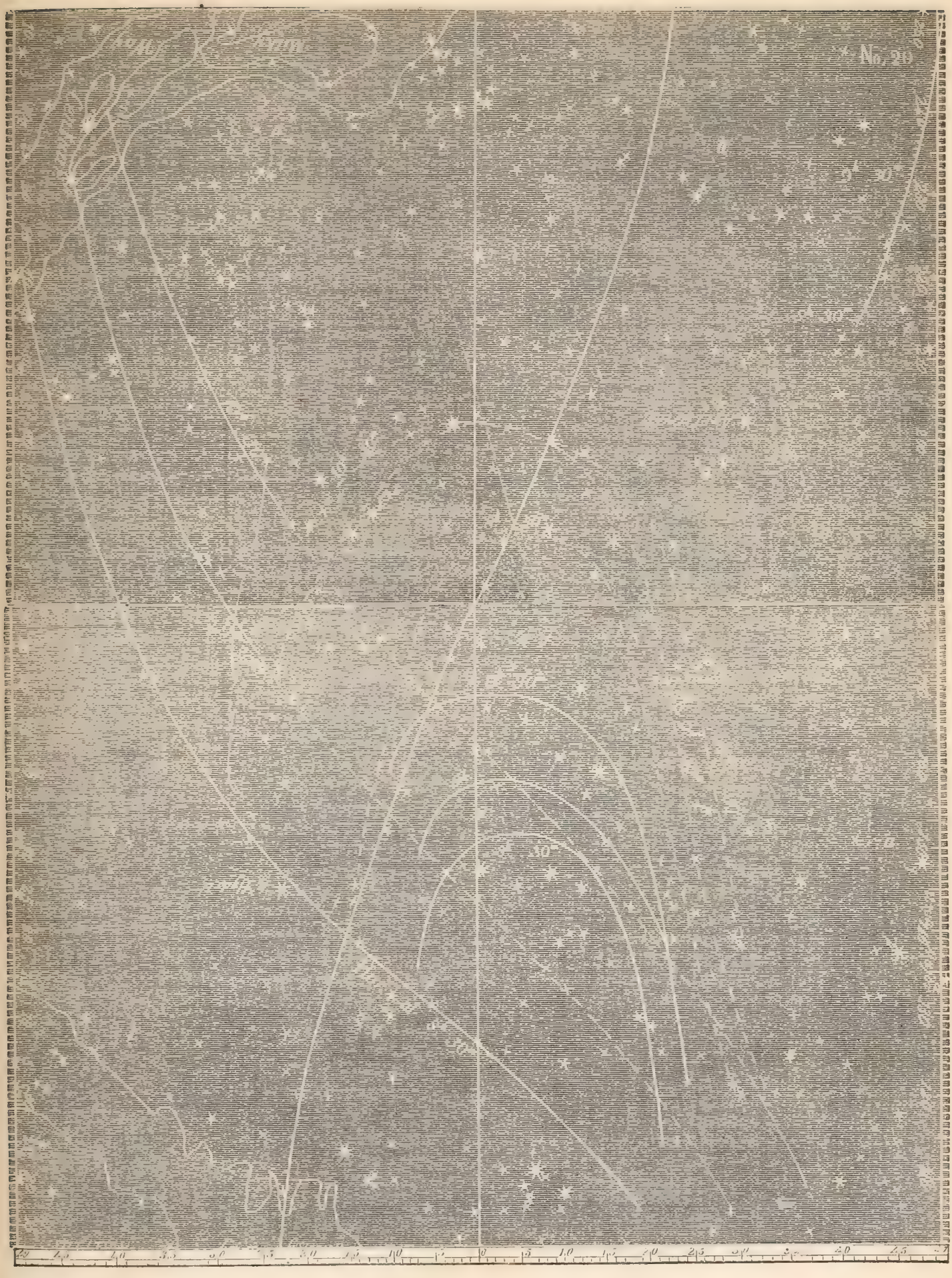
Stronger Light at 8*h*. 30*m*.		Diffuse at 8*h*. 30*m*.	
9	0	9	0
9	30	9	30
		10	30

Sun's Longitude, 99° 28′.

Had very good observations of the Zodiacal Light. Dr. ——— and Mr. S——— were with me at half-past 8, and both agreed in the inferior darkness ("blueness" they called it) of the sky, and the inferior brilliancy of the stars within the wide limits already noticed. I got them to give the boundaries, and we all agreed in them as given in the chart in the outer, or dotted line, *a a*.

At that time the gauzy light showed itself within the line of dashes, and the Stronger Light within the full line, marked for that hour; and so with the other hours. At $10^h\ 30^m$ there was no Stronger Light. At 11 o'clock there was only a dim marking of light about 43 Virginis, of which I could not get the boundaries. All through the evening the light passed off, at the right, into something which did not seem to be the Zodiacal Light, but stretched along the horizon in a space about 6° wide, till it met the Milky Way.

[P. S., December 9, 1853.—The character of the Zodiacal Light for this season seems to have better developed itself on this evening; and the charts from this on, for some time, have three kinds of boundaries: 1st. The dotted, giving the boundaries of the sky where it is simply made pale, without any positive light; 2dly. The lines of dashes, showing where the positive light ("Diffuse") commences; and 3dly. The full lines, giving the boundary of the "Stronger Light." Something of this kind seems to have shown itself on the evening of the 29th; but it was new, and we only get hints of it in the chart of that evening.]


No. 20

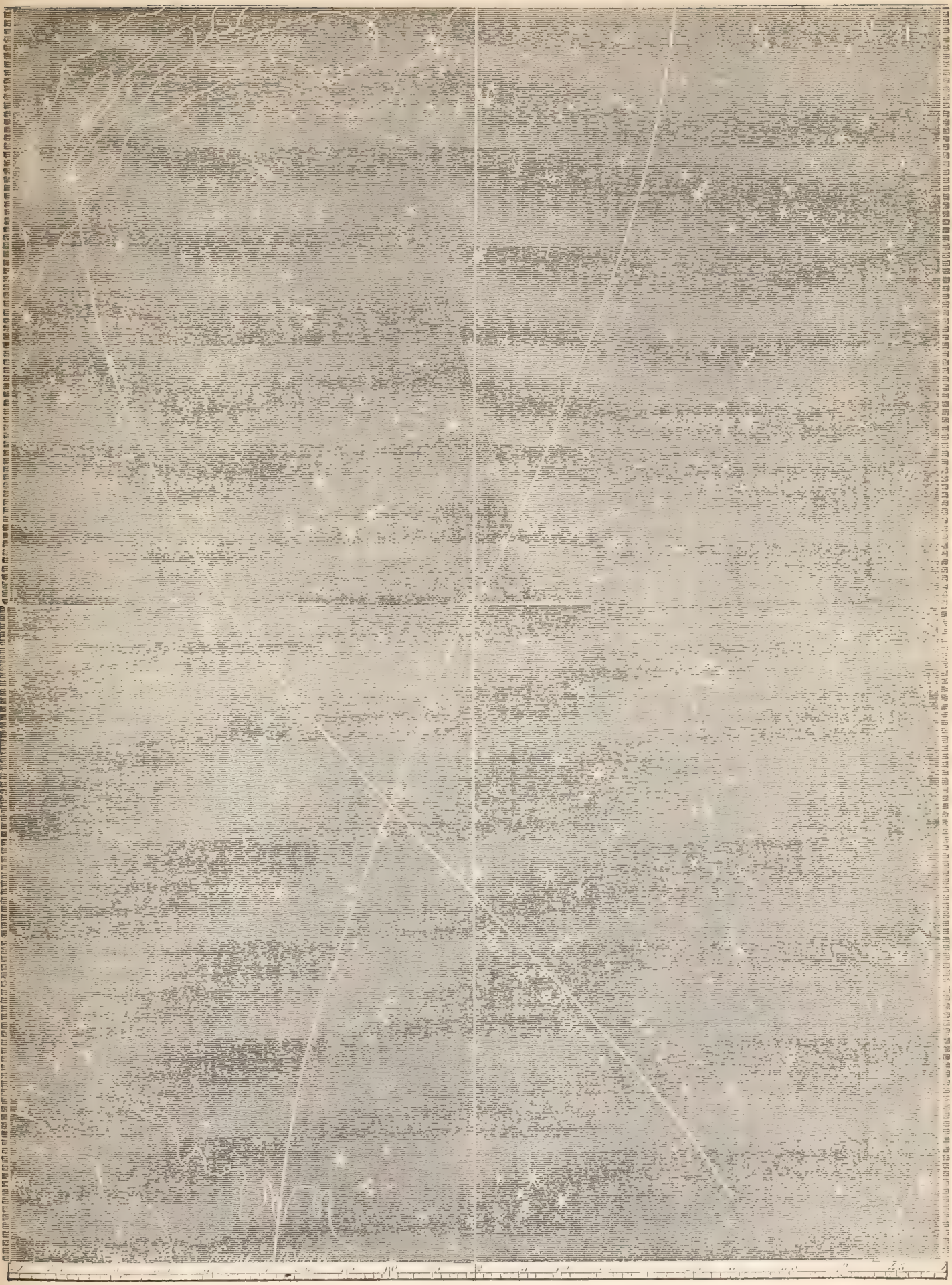
No. 21.

JULY 2d, 1853 : Evening.

Lat. 26° 10′ N.: Lon.
Sun set 6*h*. 51½*m*.
Diffuse Light at 9*h*. 30*m*.

Clouds in the early part of the evening. At $9^h\ 30^m$ had an observation. Darkish clouds soon began to cross this space, which, by contrast, gave me a better opportunity than before of judging about the newly observed appearance within the outer or dotted lines, and tended to confirm the belief that it is real. Clouds prevented further observations.

[P. S. 1856.—This reduced chart would not admit the whole of the dotted line as given in my original observations. This line reached 52° lat. at lon. 160°, and thence continued at the same latitude to lon. 115°, where it terminated.]



No. 22.

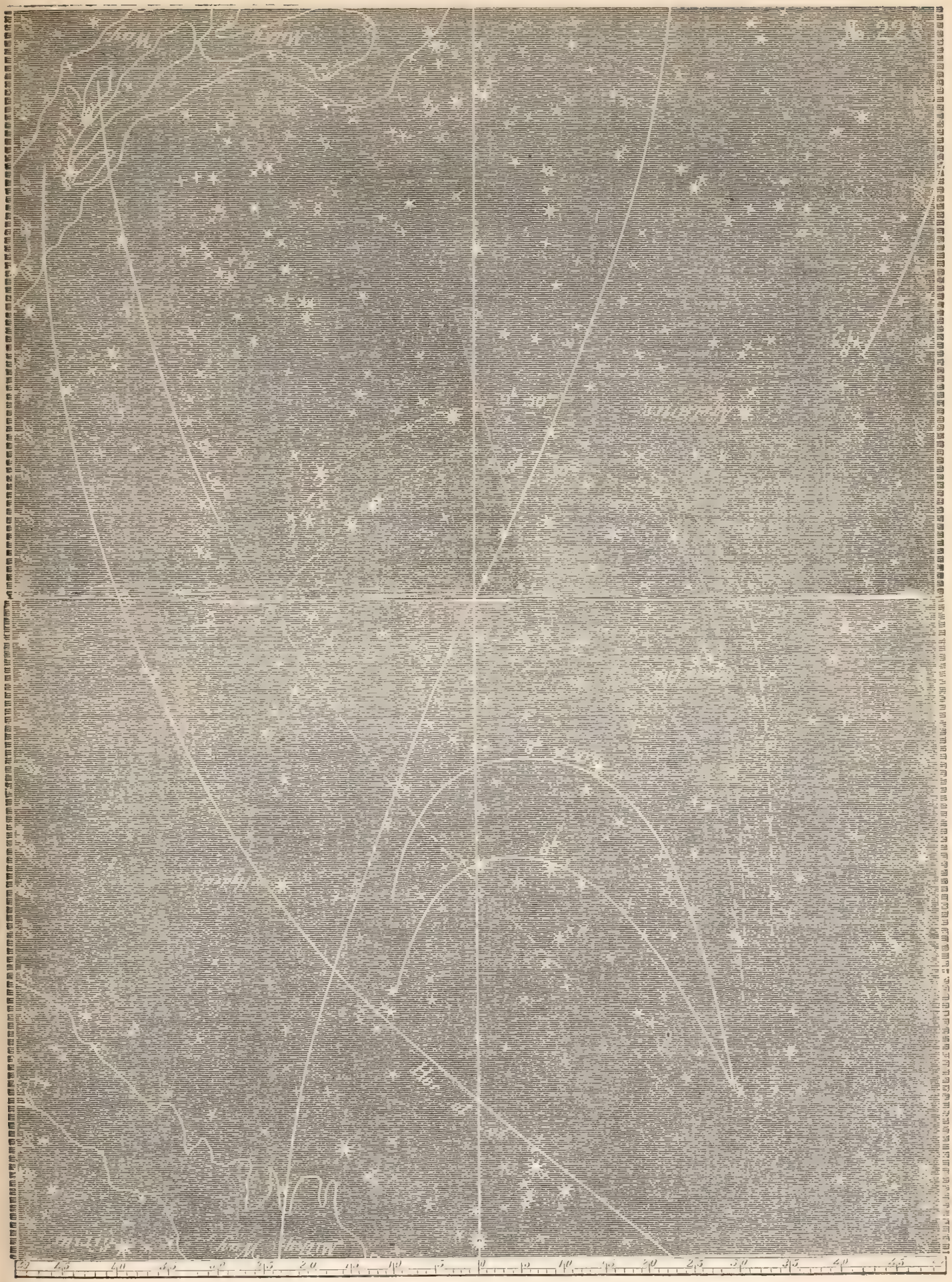
JULY 4th, 1853 : Evening (3d was Sunday).

Lat. 29° 9′ N.: Lon. 131° 28′ E.

Sun set 6*h*. 58*m*.

Stronger Light at 8*h*. 0*m*.	Diffuse at 8*h*. 0*m*.
8 30	8 30
	9 30

Flying clouds this evening, but had good observations; results are given in the chart. The dimmed or paled sky, as before; it is bounded by the dotted line. I cannot see that it changes its boundaries, as the others do, while the night advances. At $9^h\ 30^m$ there was no Stronger Light, and the Diffuse was very dim. Then came clouds, and I could have no further observations.

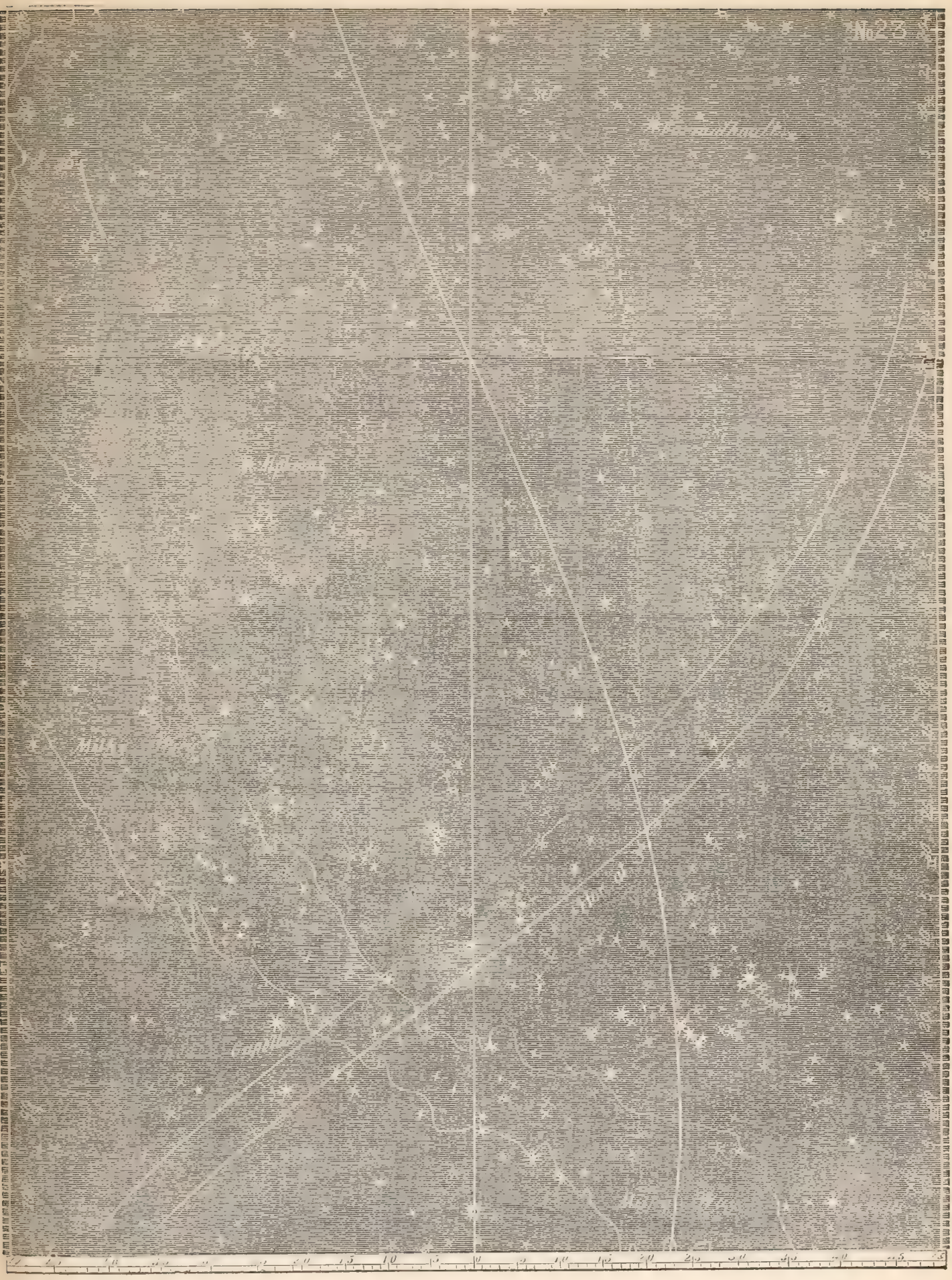


No. 23.

JULY 5th, 1853 : Morning.

Lat. at 2*h.* 30*m.*, 29° 36′ N.: Lon. 132° 5′ E.
Sun rose 5*h.* 9*m.*
Diffuse Light at 2*h.* 30*m.* and 3*h.*

Had a fine observation this morning—the sky clear, and the Zodiacal Light very decided. There was no decided "Stronger Light," though, toward the Pleiades, the Light gradually changed into a whiter appearance, of which they were the centre. Probably the Milky Way prevented anything decided in this respect. I looked carefully for "a dimmer sky" and "dimmer stars" beyond these lines—such as we have in the evening; but could not discern any.


No 23

No. 24.

JULY 5th, 1853 : Evening.

Lat. at 8*h*. 30*m*., 30° 47′ N.: Lon. 133° 35′ E.
Sun set 7*h*.

Stronger Light at 8*h*. 30*m*.		Diffuse at 8*h*. 30*m*.	
9	0	9	0
		9	30

I watched carefully, this evening, to see how the Zodiacal Light would first disclose itself to the sight. The evening good and clear. After the purple sunset-light was gone, a bright, steel, light succeeded along the horizon, seemingly common twilight. This remained; but at 8^h its horizontal limits had contracted so, as to extend but 17° S. and 55° N. of Venus,* then near setting. Its height was 20°; towards its southern end this light began gradually to slope upward; and also, on the sky above, an elongated, dim, milky light, gradually impressed itself. At first it was doubtful; then less so; then, at 8^h 15^m, it was decidedly the Zodiacal Light reaching as high as 94 Leonis Majoris, and having the usual outlines of this Light. It was, however, dim above. At 8^h 30^m the whole was clearly marked and distinct, and I was able to get outlines. At 9^h 30^m there was no Stronger Light; at 9^h this was not strong, but stronger than the rest. At 10^h 30^m there was only a slight suffusion of light between the boundary of 9^h 30^m and the horizon. The dotted line *a a* shows the boundary of "the dimmed sky" as before.

At 8^h 30^m the bright sky on the right, into which the Zodiacal Light seems to run (if it is not a continuation of it), extended 170° in width along the horizon till it reached 75° N. from Regulus: its upper edge thus extended within 15° of the polar star itself.

* Venus had then 25° of N. declination (geocentric).

No. 24

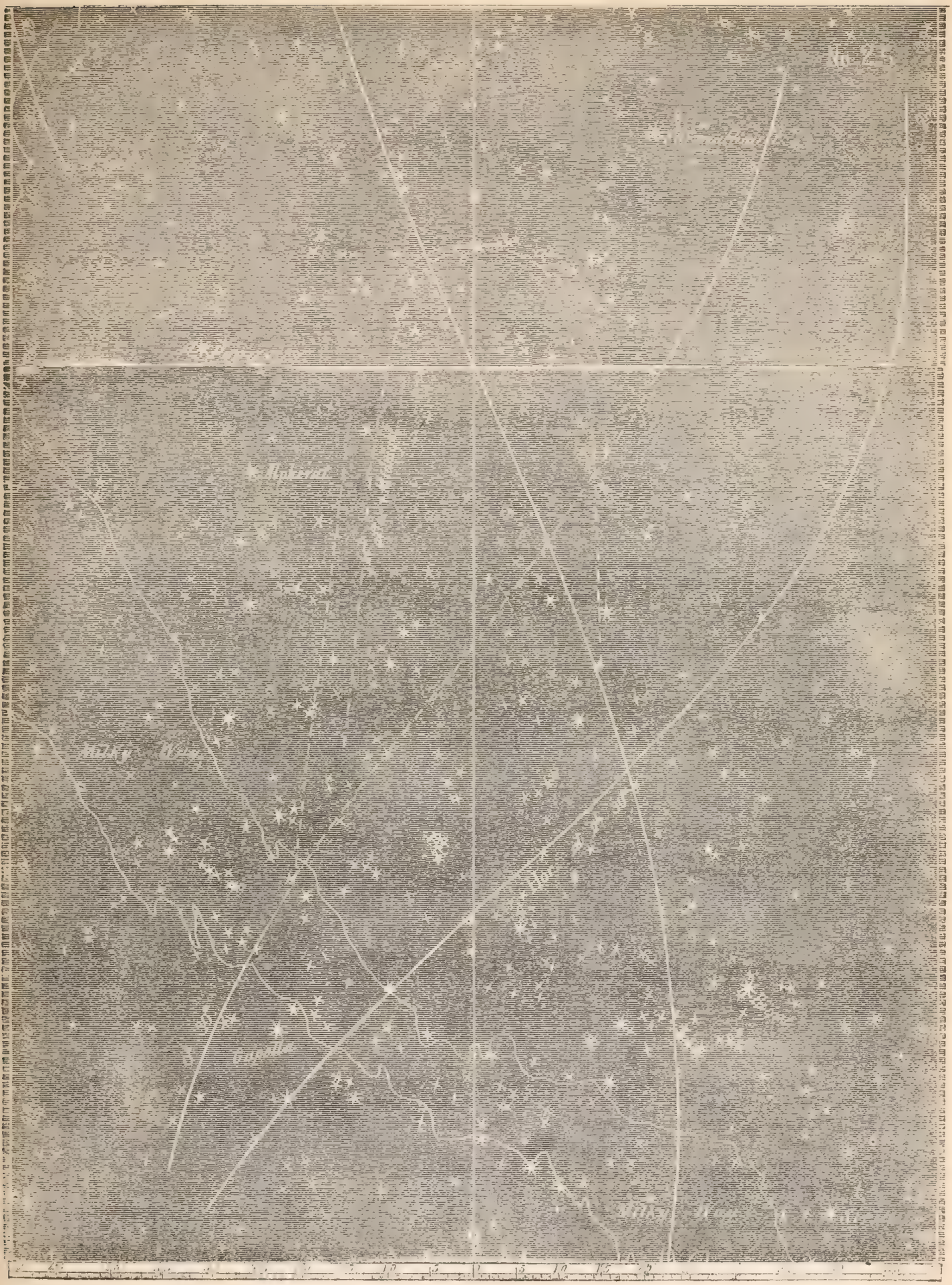
No. 25.

JULY 6th, 1853 : Morning.

Lat. at 2*h.* 30*m.*, 31° 8′ N : Lon. 134° 31′ E.
Sun rose 5*h.* 6*m.*
Diffuse Light at 0*h.* 30*m.* and 2*h.* 30*m.*

Went on deck at half an hour after midnight, and was surprised to find the Zodiacal Light, at this early time, quite distinct. I asked the officer of the deck, Lieutenant M——, if he could distinguish it; and he had no difficulty in doing so. I could see also that the whole of that portion of the heavens enclosed between the Milky Way and the horizon, 75° wide (midway across which, slantingly, the Zodiacal Light passed), was not so black, and that the stars were not so bright, as in the portion of the sky on the other side of the Milky Way, between Corona Borealis, and the horizon N. of it, in which Lieutenant M—— also agreed with me. His answer was: "Yes, now I can see it, since you point it out." The portion of the dimmed sky of last evening's observations, still in sight, was also as dim as in the evening.

There was a very splendid meteor this morning, just before I went on deck. It cast quite a strong light on the deck.


Aldebaran
Capella

No. 26.

JULY 6th, 1853 : Evening.

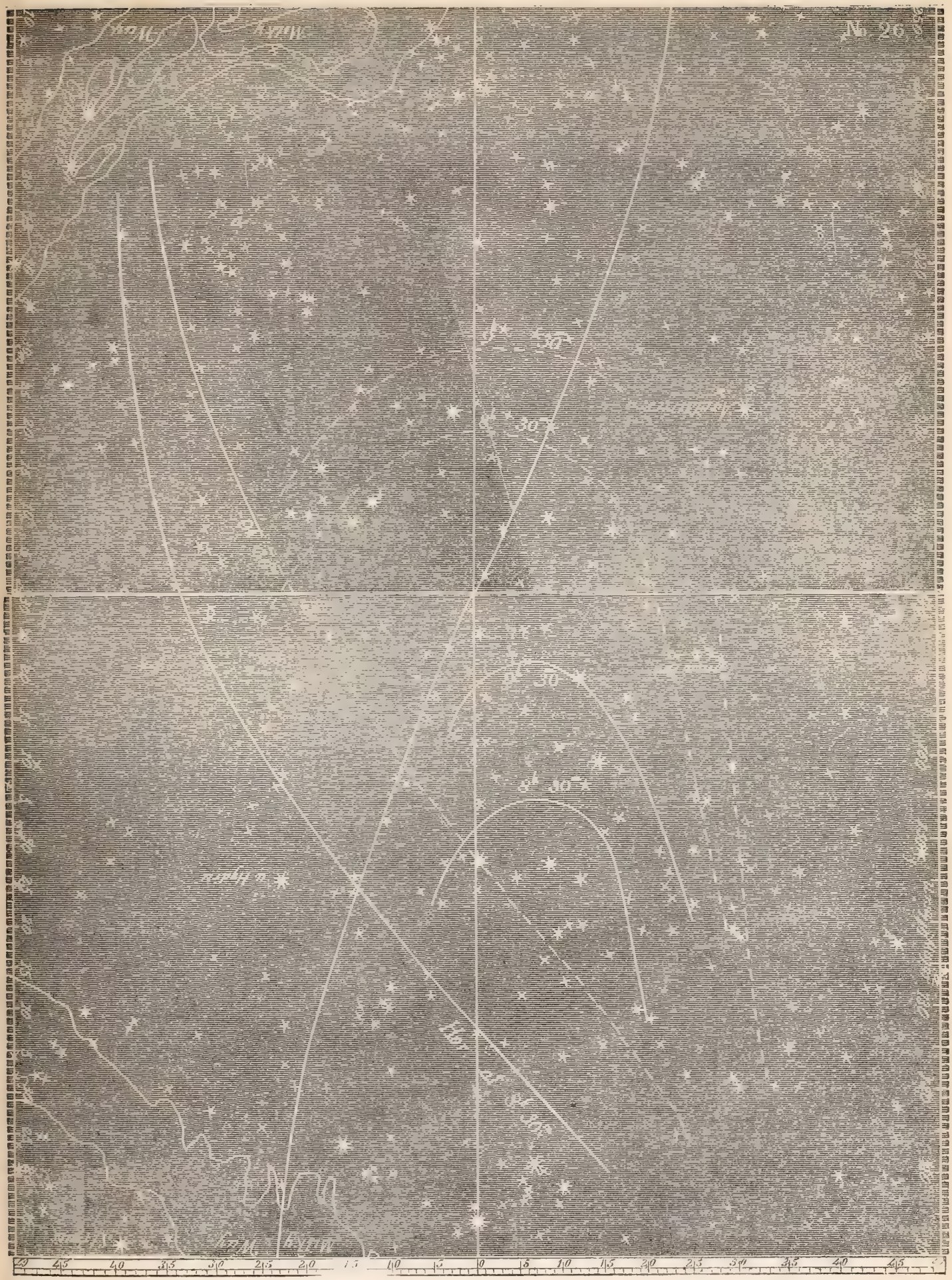
Lat. at 8*h*. 30*m*., 32° 13′ N.: Lon. 136° 34′ E.
Sun set 7*h*. 5*m*.
Stronger and Diffuse Light at 8*h*. 30*m*. and 9*h*. 30*m*.
Zenith point, at 8*h*. 30*m*.,Lat. 49° 0′ N.: Lon. 217° 30′.
" 9 30 53 15 238 0

Clouds prevented any observations till $8^h\ 30^m$. Afterwards, the view was interrupted by flying cirri; but still I was able to get reliable boundaries.

The outlines of the paled sky are marked as before, by a dotted line *a a*.

At 10 o'clock the Light was strongest about 94 Leonis Majoris, where it was equal to that of the Milky Way, in the head of Scorpio, or about 10, 11, 14, and 15 Sagittæ.

[P. S., 1856.—I am not able, in this reduced chart, to insert all of the dotted line. In my original chart, at lon. 180° it reaches 49° 30′ lat. ; it terminates at 125° of lon., in lat. 52°.]


N. 26
30
30
30
30
45
40
35
30
25
20
15
10
5
0
5
10
15
20
25
30
35
40
45

No. 27.

JULY 7th, 1853 : Morning.

Lat. at 3 o'clock, 32° 36′ N.: Lon. 137° 26′ E.
Sun rose 5*h*. 2*m*.
Stronger Light at 3*h*. Diffuse at midnight and 3*h*.

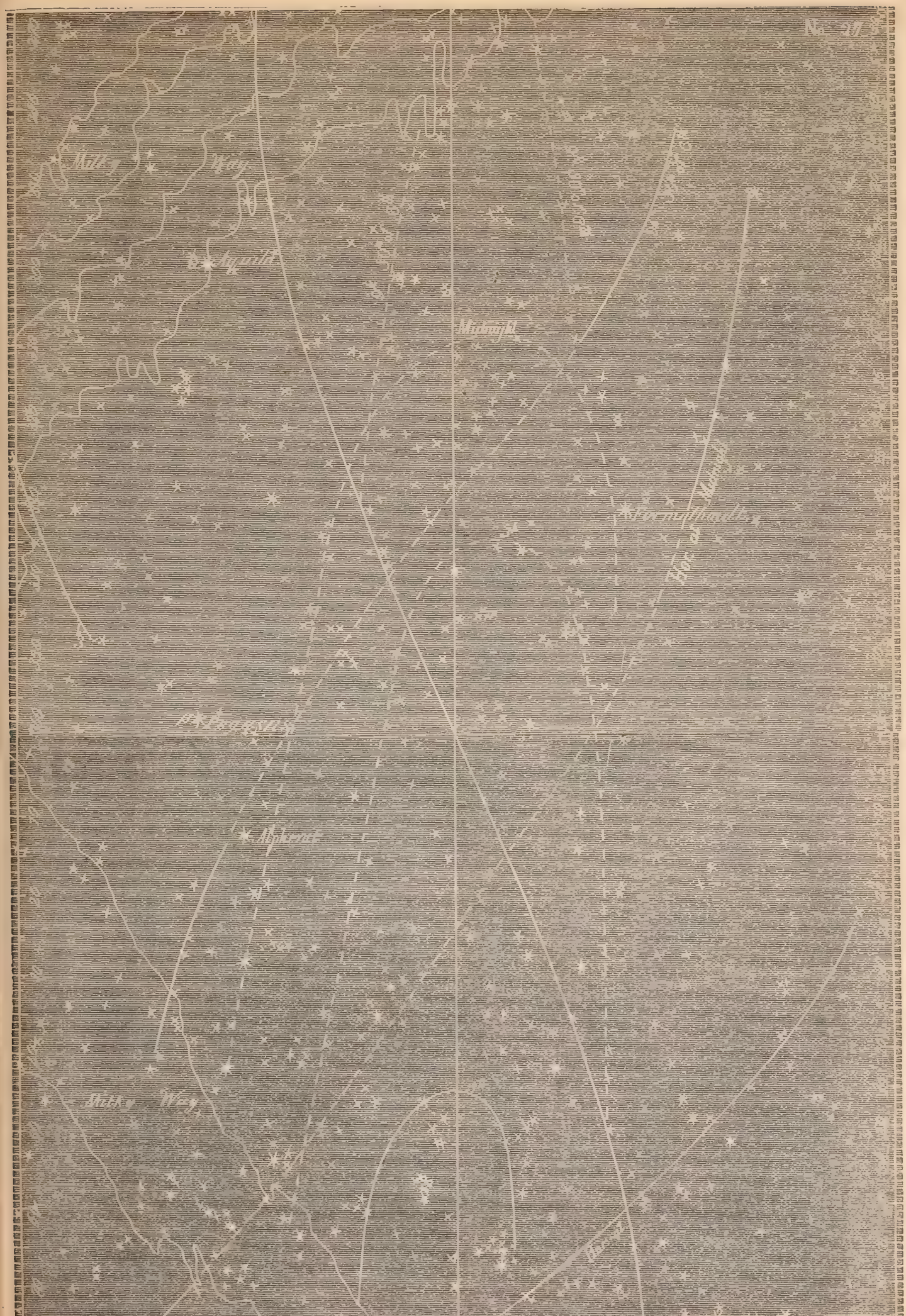
My observations at half-past 12, yesterday morning, led me to attach more importance to appearances noticed several evenings before at 10 and 11 o'clock—namely, something like the Zodiacal Light in the *east*, at those early hours. I had not recorded them, as I gave them little weight. Last evening, however, I turned to the east, at 9 o'clock, and took note of the appearances; though, from their vicinity to the horizon, I think nothing decided can be drawn from them. Still they are worthy of remark. The outline of this Light for $9^h\ 30^m$ is given in the chart. Its upper part was lost in the Milky Way.

At $11^h\ 30^m$ p. m., I went on deck for another examination of the same; and continued observing till midnight, at which time its outline was taken, as in the chart. This Light at 90, 91, 92, 93, and 95 Aquarii, was as strong as that about 11, 12, 13, 14, 15, and 16 Sagittæ (just above Delphinus). During these observations, I was inclined to confidence that this was the true Zodiacal Light; but, when I went on deck again, at $2^h\ 30^m$ a. m., and saw the undoubted Zodiacal Light stretching up in the sky, I thought I could see a difference; the latter looking soft and gauzy, unlike the hard look of the former. I have, however, given the boundaries of all from $9^h\ 30^m$ to 3^h a. m.

The dim sky under the Milky Way was the same as yesterday morning.

[P. S., 1856.—It will be seen from this journal, that this light in the east was seen subsequently on several nights (July 9th, &c.) I finally came to the conclusion, from its position, that it was not the Zodiacal Light (in this I was mistaken); and although, during the next year, I saw it repeatedly in the evening at the same hours—*i. e.* about 9 or 10 o'clock—I made no record of it, which I now greatly regret. I was fearful that I might embarrass the true observations by others, of what was not truly Zodiacal Light; but who shall say what is and what is not truly such? Therefore, nothing that seems to have a possible connexion with the subject is too small or too slight to be noted.

It is possible that this nebulous matter, whatever it is, is self-luminous, and thus gave me this light in the east; but, more probably, it was still a reflection from the sun.]

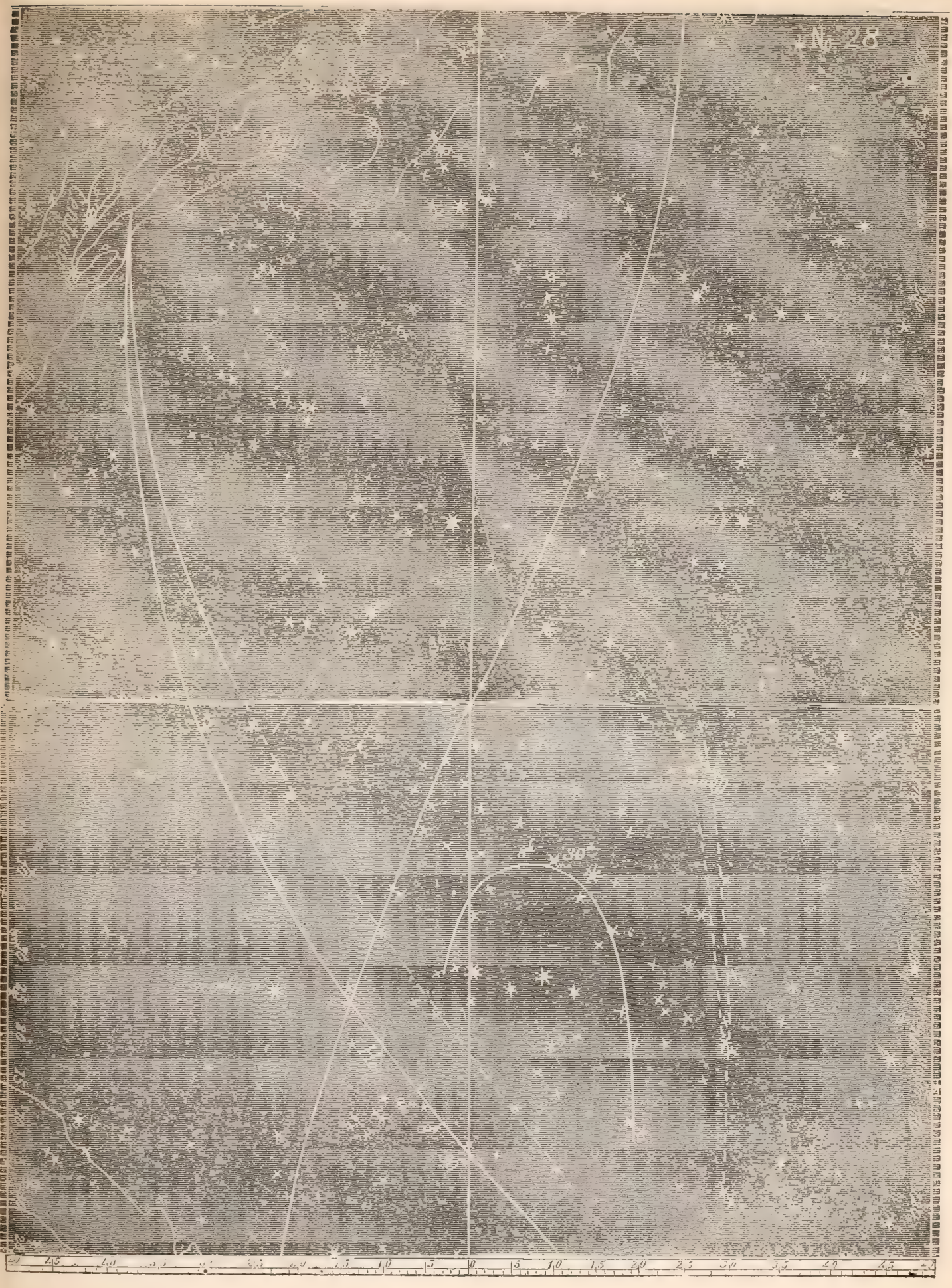

Milky Way
Aquila
Midnight
Vernal Equinox
Altair
Milky Way

No. 28.

JULY 7th, 1853 : EVENING.

Lat. at 8*h.* 30*m.*, 33° 50′ N.: Lon. 138° 53′ E.
Sun set 7*h.* 9½*m.*
Stronger Light at 8*h.* 30*m.* Diffuse, 8*h.* 30*m.* and 9*h.*
Sun's longitude, 105° 11′.
Zenith point, at 8*h.* 30*m.*, Lat. 50° 35′. Lon. 217°.
" 9 0 " 53 8 " 228

Clouds in the early part of the evening. Had good observations at 8^{h} 30^{m} and at 9 o'clock, for which see chart. At 9^{h} there was no Stronger Light. After this, the sky, for some distance up from the horizon, became hazy. The paled portion of the sky now extends up quite to the Milky Way.

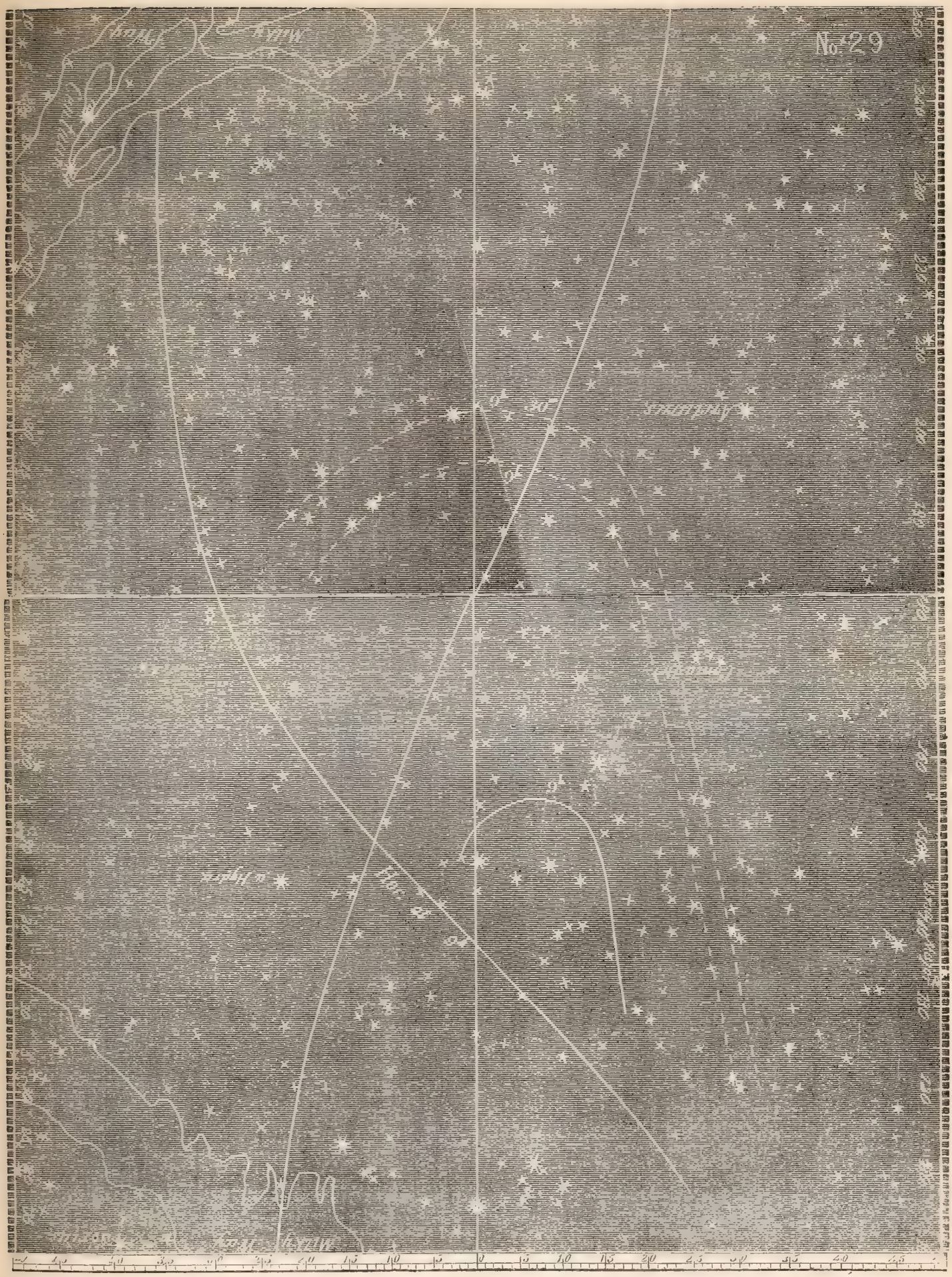

№ 28

No. 29.

JULY 8th, 1853: Evening.

Lat. 35° 12′ N.: Lon. 139° 44′ E.
Sun set 7*h*. 13*m*.
Stronger Light at 9*h*. Diffuse, 9*h*. 0*m*. and 9*h*. 30*m*.
Zenith point, at 9*h*., Lat. 54° 25′N.: Lon. 228°.

Observation, this morning, prevented by clouds. The moon this evening interfered with the Zodiacal Light till 9 o'clock; then got observations. At $9^h\ 30^m$ the Light was very dim—scarcely perceptible. Even the Stronger Light at 9^h was feeble compared with its recent appearance.


No. 29

No. 30.

JULY 9th, 1853 : Morning.

Lat. 35° 12′ N.: Lon. 139° 44′ E.
Sun rose 4*h*. 58*m*.
Stronger and Diffuse Light at 3*h*. 0*m*. and 3*h*. 30*m*.

Was up at $2^h\ 30^m$; the sky not at its brightest, but still pretty good. Found it difficult to get exactly the limits of the Diffuse Light at their upper extremity, owing to its dimness. At $3^h\ 30^m$ the Stronger Light was very bright, and showed itself decidedly, even in the Milky Way. Indeed, I should have supposed it to be dawn, but for its confined limits. These, now, gradually spread, and soon ended in the dawn.

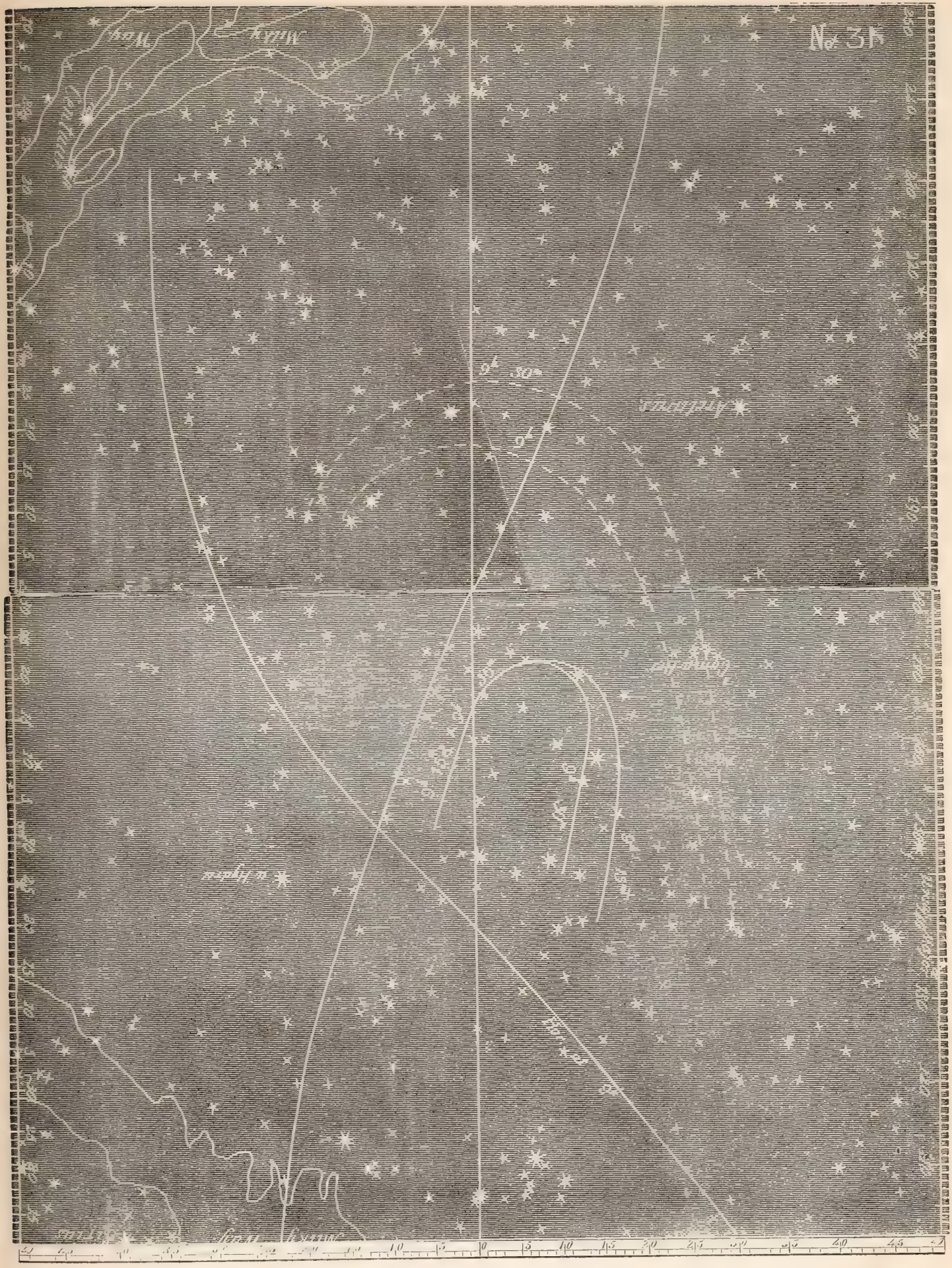
No 30
Milky Way
Milky Way

No. 31.

JULY 9th, 1853 : Evening.

Lat. 35° 12′ N.: Lon. 139° 44′ E.
Sun set 7*h.* 12*m.*
Stronger and Diffuse Light at 9*h.* 15*m.* and 9*h.* 30*m.*
Zenith point, at 9*h.*, Lat. 54° 40′ N.: Lon. 229°.

Moon interfered with the Zodiacal Light till 9^h 15^m, when it set. The atmosphere was remarkably clear, and the Light better than several evenings previous at these hours. At 10^h, atmosphere still clear, but the Zodiacal Light proper was gone, except a brightish spot from 94 to 70 and 68 Leonis Majoris; but, although the elongated Zodiacal Light had no longer its proper limits, it seemed now to have ascended, and widened over what I have usually called the dimmed or paled sky; all of which was now filled with a whitish light, so as to be very striking.


No 31

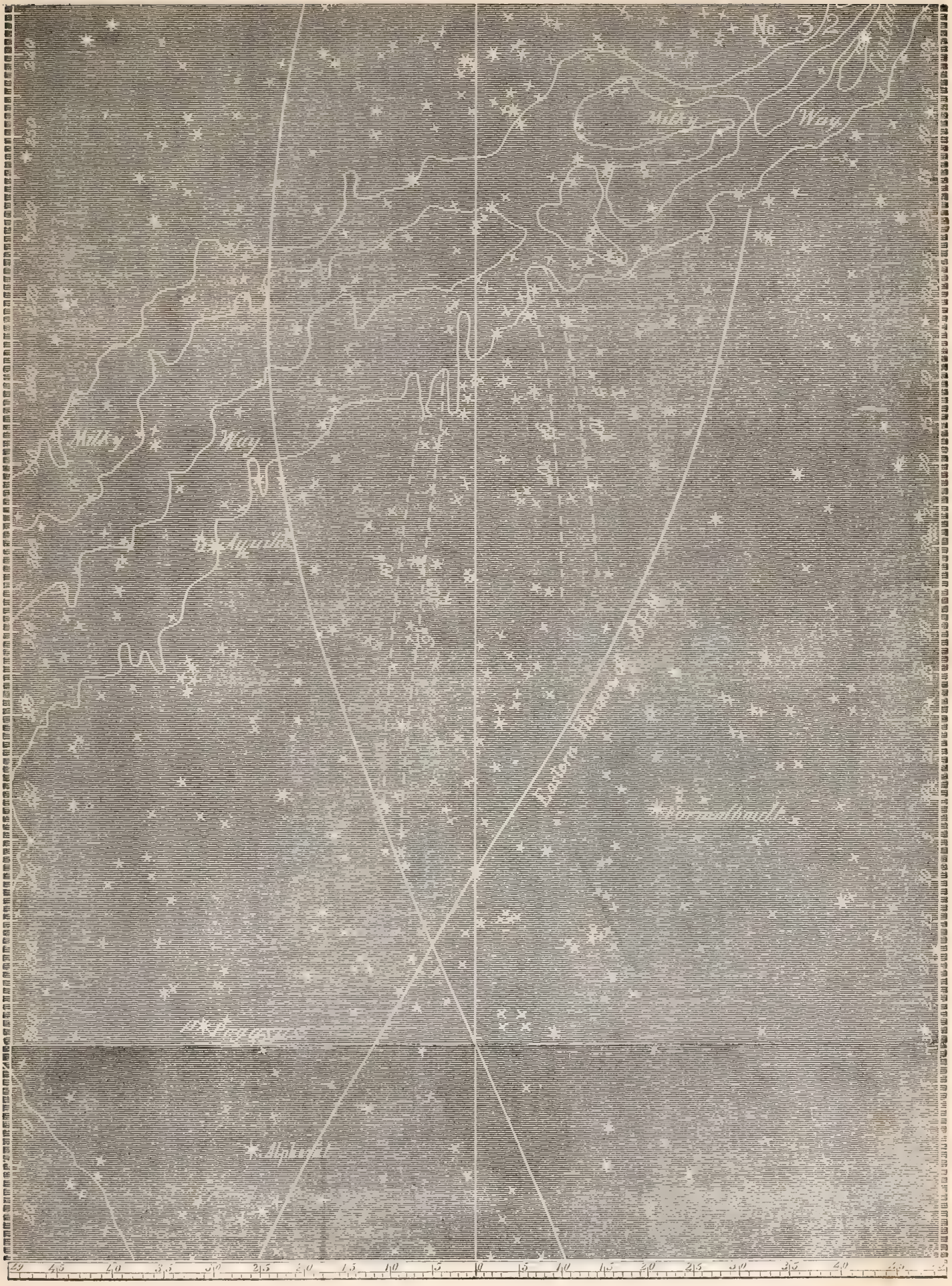
No. 32.

JULY 9th, 1853 : EVENING.

Lat. 35° 12′ N.: Lon. 139° 44′ E.
Sun set 7*h*. 12*m*.
Zodiacal Light in the *East* at 9*h*. 30*m*. and 10 o'clock.

At $9^h\ 30^m$, I turned to the eastern sky, and thought that I could make out a strip of brightness with boundaries as in the chart. At 10^h, this brightness was more striking; and I could have no suspicion, in this case, as on a former occasion (see No. 27), that it was an accidental brightness of the horizon: for there was now a dark haze between its lower part and the horizon. Still I had some doubts of its being the true Zodiacal Light. At $10^h\ 45^m$ it was so strong as very much to dissipate doubt. I could scarcely resist the full conviction that it was the real Zodiacal Light.

[P. S., 1856.—See No 42, for another observation of this kind, and for remarks.]


No 32
Milky Way
Milky Way
Aldebaran
Pleiades
Algol

No. 33.

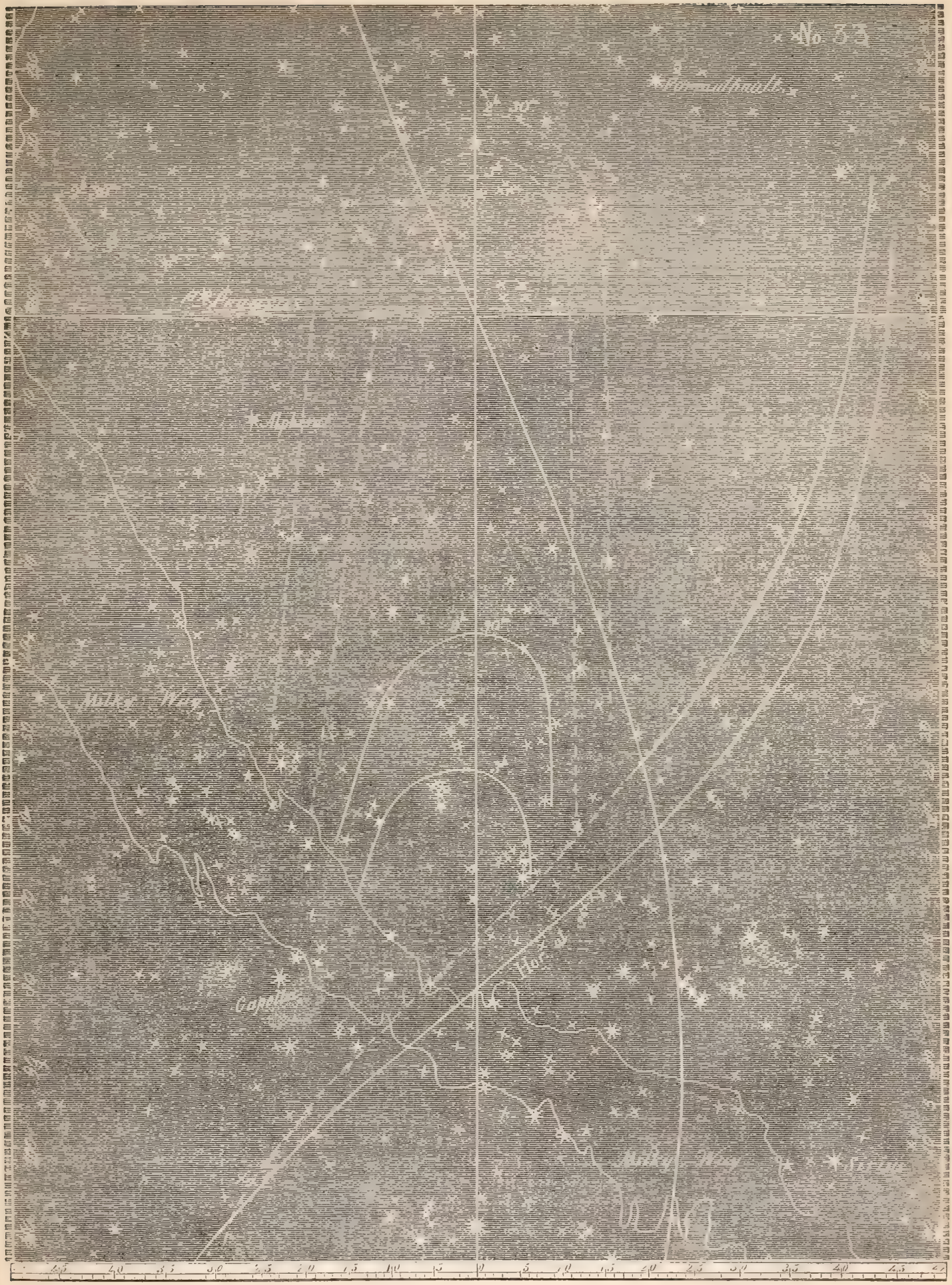
JULY 11th, 1853 : Morning.

Lat. 35° 12′ N.: Lon. 139° 44′ E.

Sun rose 4*h*. 59*m*.

Stronger and Diffuse Light at 2*h*. 30*m*.

Rose at $2^h\ 30^m$ and took observations. It is difficult now to get boundaries to the Stronger Light, it changes so gradually and evenly into the Diffuse.

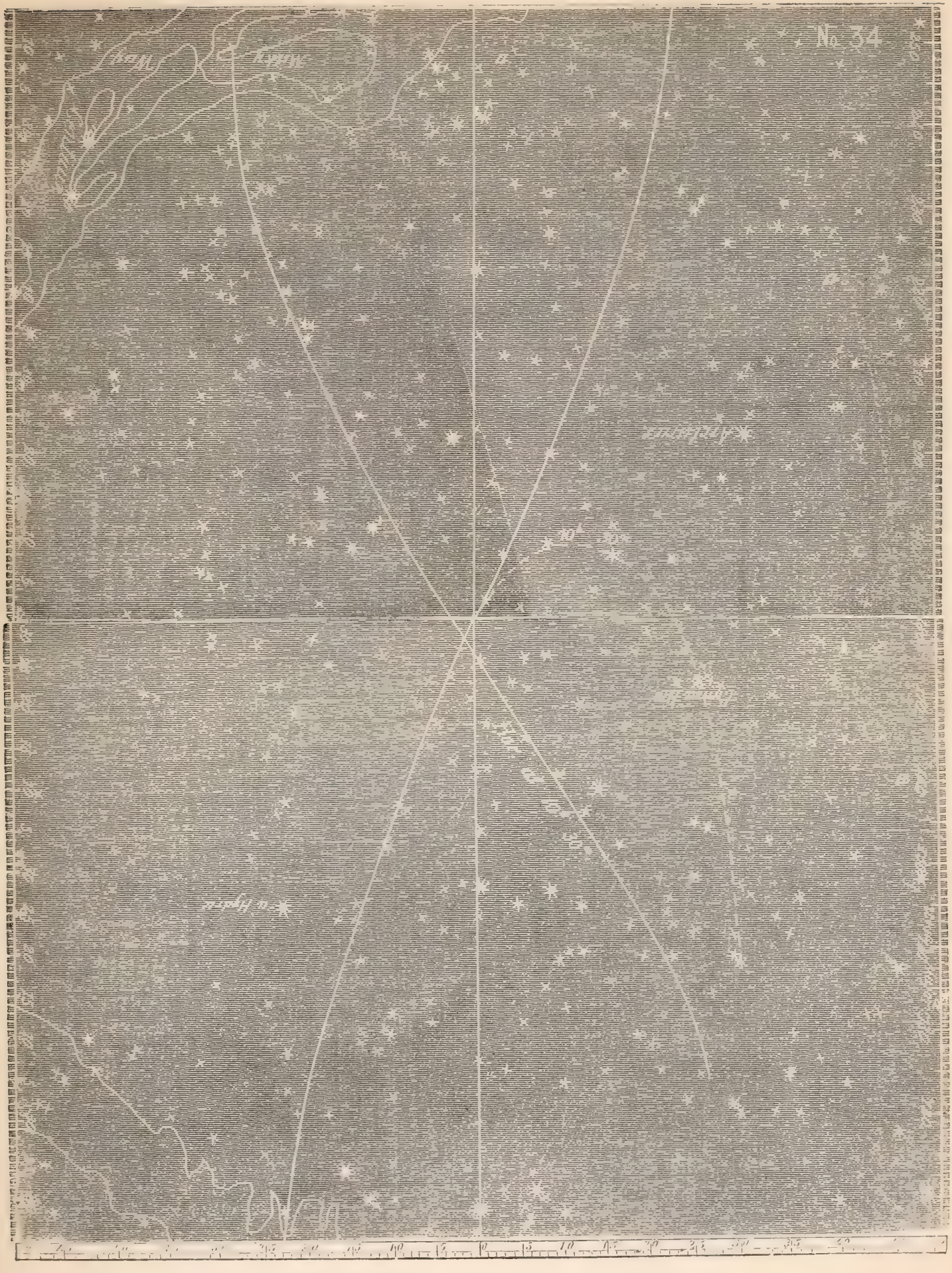

No 33
Milky Way
Milky Way

No. 34.

JULY 11th, 1853 : Evening.

Lat. 35° 12′ N.: Lon. 139° 44′ E.
Sun set 7*h*. 11*m*.
Diffuse Light at 10*h*. 30*m*.
Zenith point, at 10*h*. 30*m*., Lat. 58° 30′ N.: Lon. 263°.

Moon in the early part of the evening. At $10^{h}\ 30^{m}$ went on deck. Sky very clear. Some remains of the Zodiacal Light still very distinct. The sky above, heretofore called "the dim or paled sky," is beginning to show decided and positive Zodiacal Light. It was quite bright with it this evening, the boundaries running from 64 Ursæ Majoris, &c., as in the chart, marked *a a a*.


No. 34

No. 35.

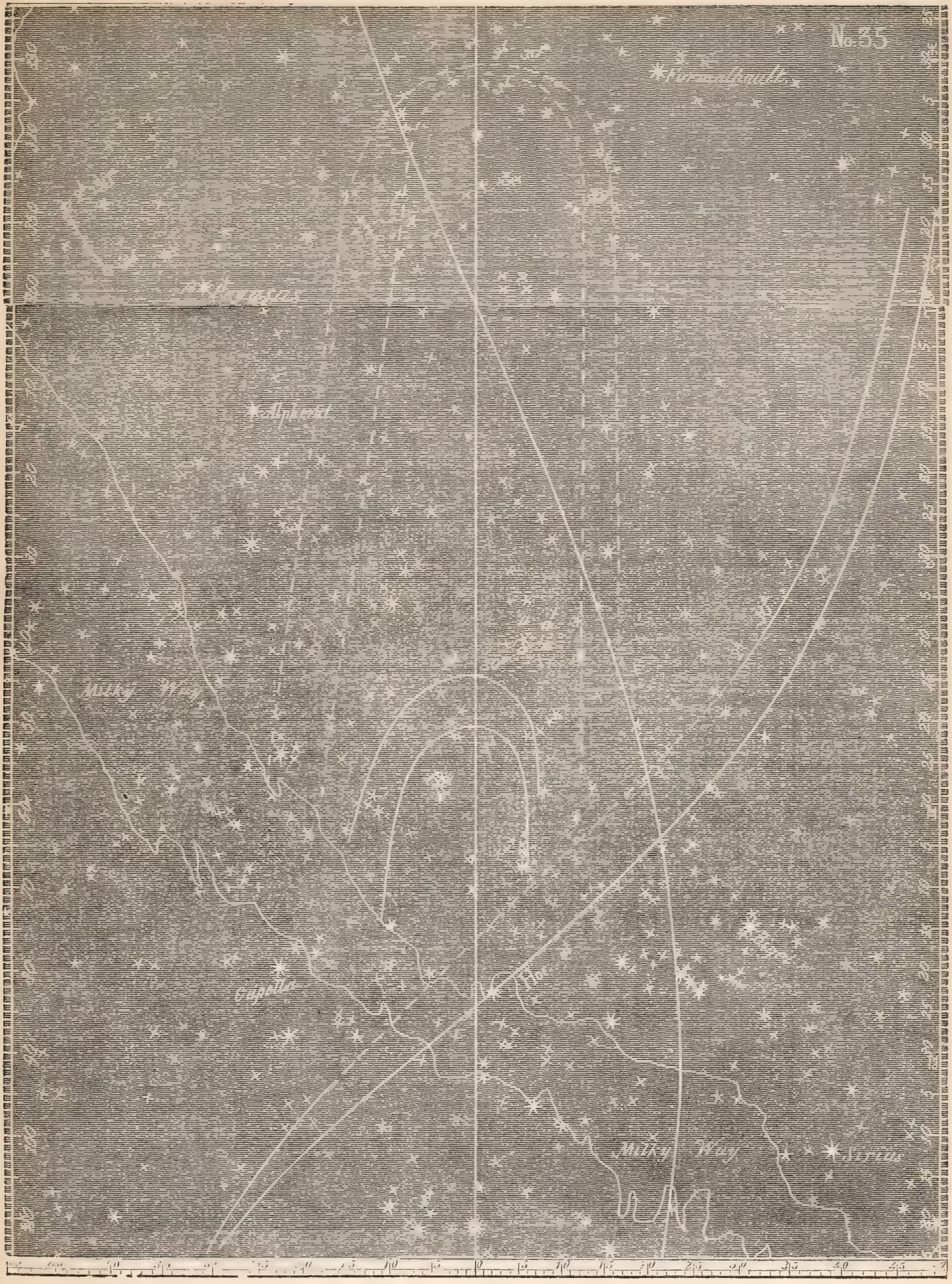
JULY 13th, 1853 : Morning.

Lat. 35° 12′ N.: Lon. 139° 44′ E.
Sun rose 5*h*.
Stronger and Diffuse Light at 2*h*. 30*m*. and 3 o'clock.

Clouds yesterday morning. At $10^h\ 30^m$ last evening I examined the eastern sky, and saw the whitish appearance recorded in No. 32 of this book; it had the same boundaries as given there for 10 o'clock, and was as bright as then.

Went out again at midnight, and saw a similar brightness, but thought it too uncertain to be relied on.

Was out again at $2^h\ 30^m$; and now there could be no mistake. At $3^h\ 30^m$ also tried to get an observation; but at this hour the dawn is beginning to show itself. At $2^h\ 30^m$ the brightness between 86 and 92 Ceti and α Arietis, marked $a\ a\ a\ a$ in the chart, was equal to that of the Milky Way at 11, 12, and 14 Sagittæ.


No. 35
Procyon
Milky Way
Capella
Milky Way
Sirius

No. 36.

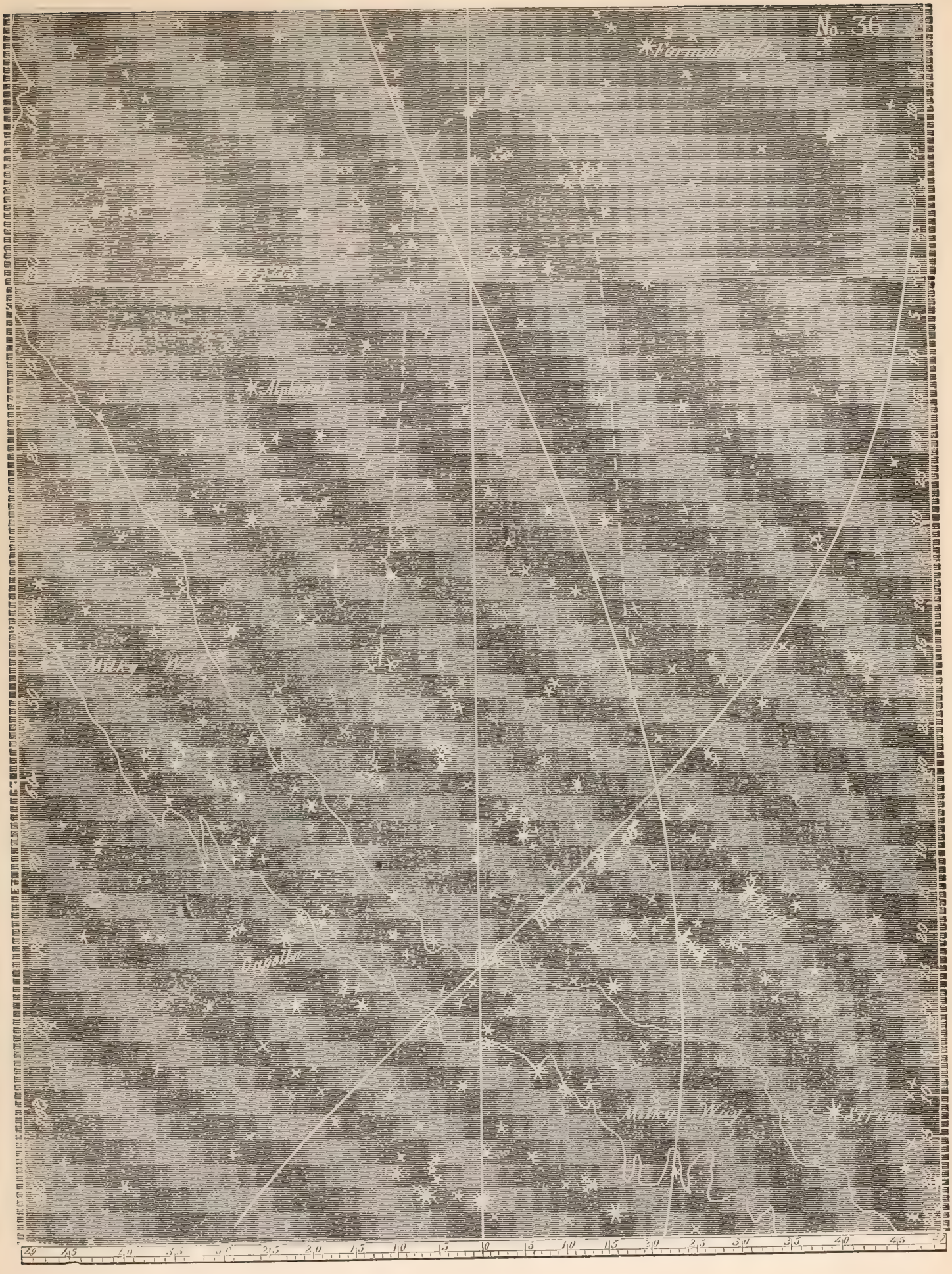
JULY 14th, 1853 : Morning.

Lat. 35° 23′ N : Lon. 139° 41′ E

Sun rose $5h.\ 0\frac{1}{2}m.$

Diffuse Light at $2h.\ 45m.$

Atmosphere hazy. Got outlines at $2^h\ 45^m$. No Stronger Light, in consequence of haziness along the horizon.

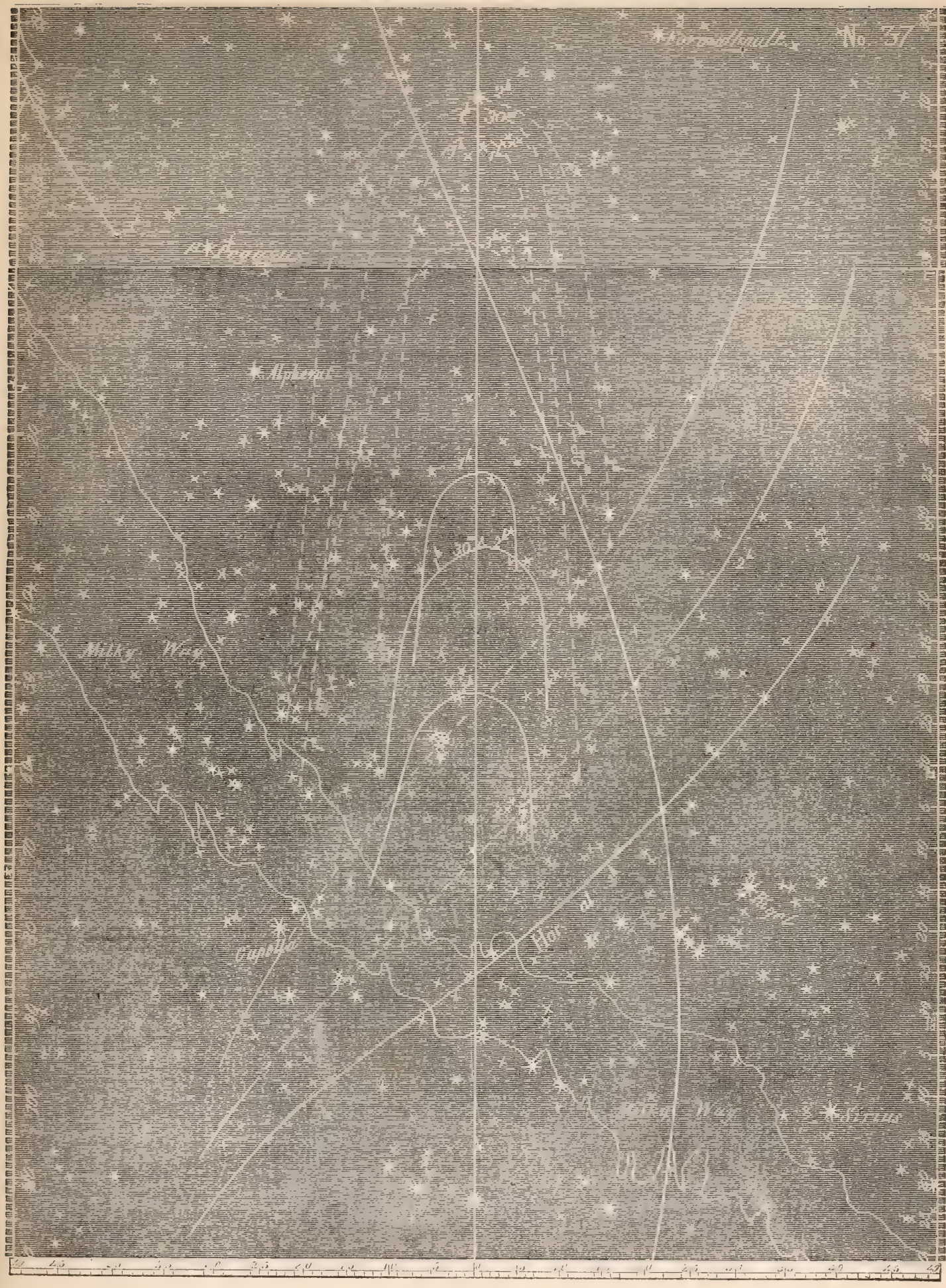

No. 36
Markab
Algenib
Alpheratz
Milky Way
Deneb
Milky Way
Arcturus

No. 37.

JULY 15th, 1853: Morning.

Lat 35° 23′ N.: Lon. 139° 41′ E.
Sun rose 5*h*. 1*m*.
Stronger and Diffuse Light 1*h*. 0*m*.
1 30
2 0
3 0

Was on deck at 1 o'clock this morning, and found the Zodiacal Light, at that hour, *perfectly distinct*. For boundaries, at different hours, see the chart. Dawn comes soon after 3^h.

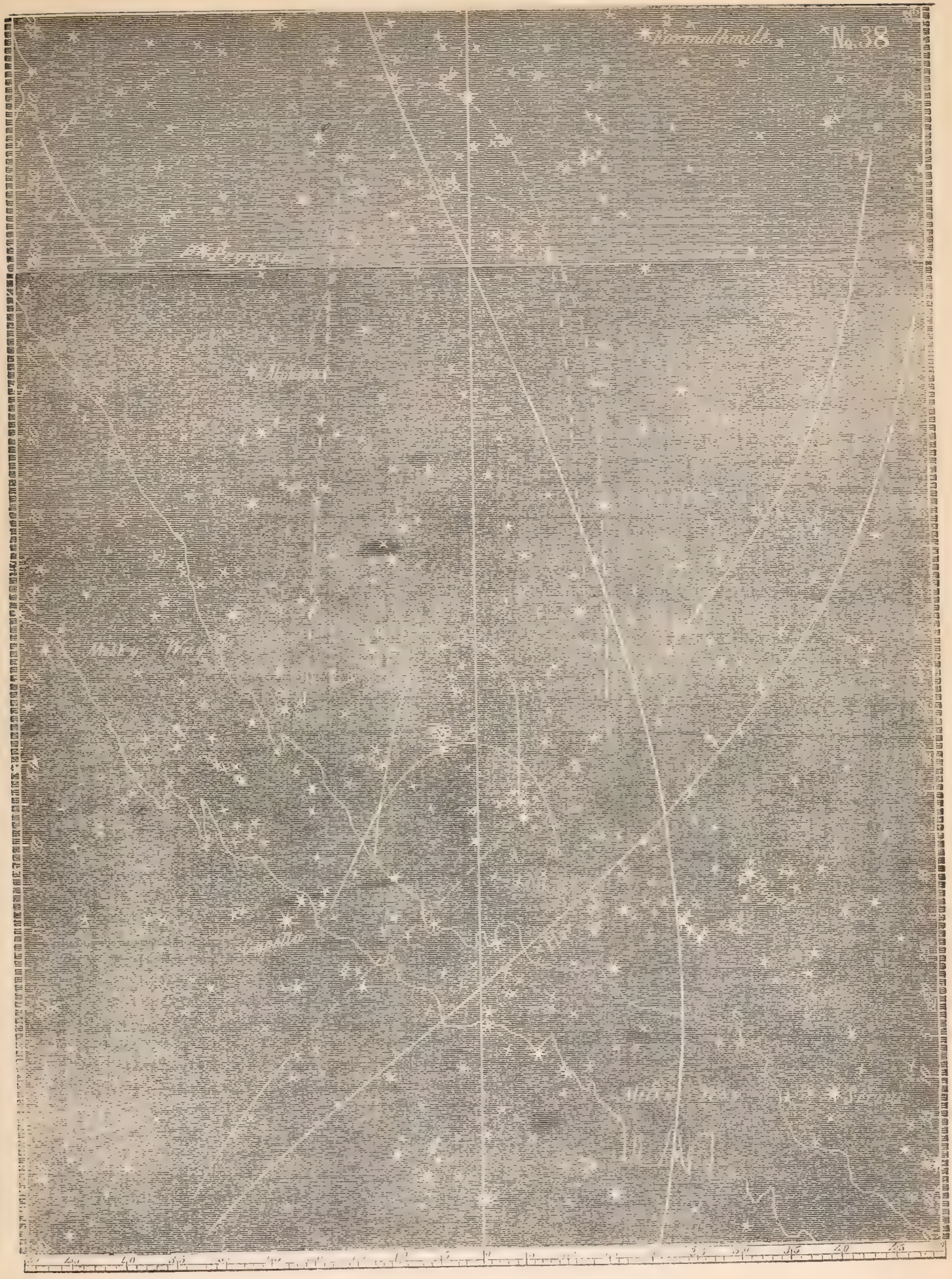

No 37
Milky Way
Milky Way

No. 38.

JULY 16th, 1853 : MORNING.

Lat. 35° 23′ N. : Lon. 139° 41′ E.
Sun rose 5*h*. 1*m*.
Stronger and Diffuse Light at 2 and 3 o'clock.

No evening observations, on account of the moon. Was called this morning when the moon had set, and took boundaries; for which see chart.


No. 38

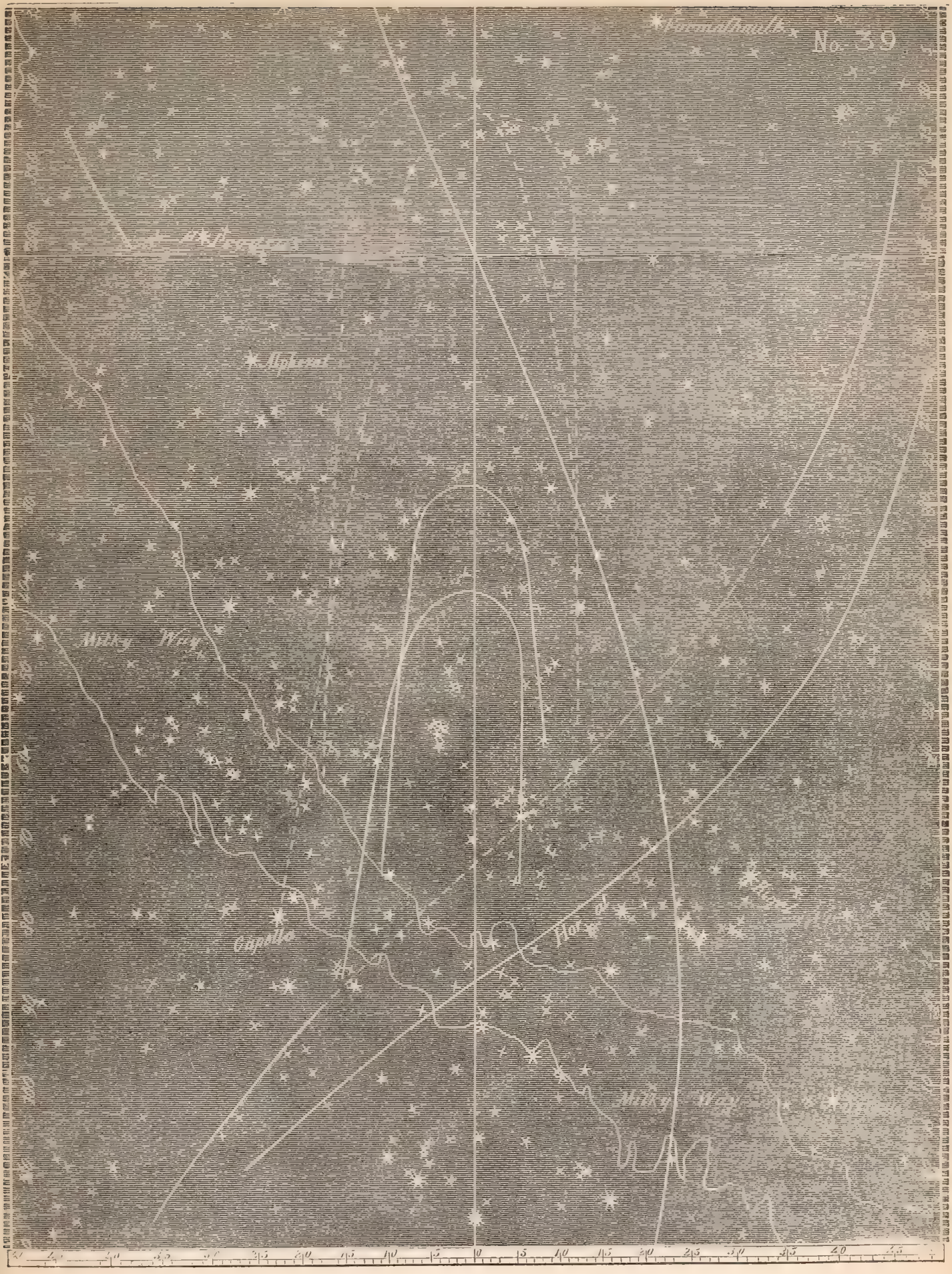
No. 39.

JULY 18th, 1853 : Morning.

Lat. at 3*h*., 33° 42′ N.: Lon. 138° 13′ E.
Sun rose 5*h*. 7*m*.
Stronger and Diffuse Light at 2 and 3 o'clock.

The moon set towards 2 o'clock.

There was a heavy rain in the early part of the night; and on going on deck, just before 2" this morning, I found the atmosphere remarkably clear, and the sky unusually fine for observations.

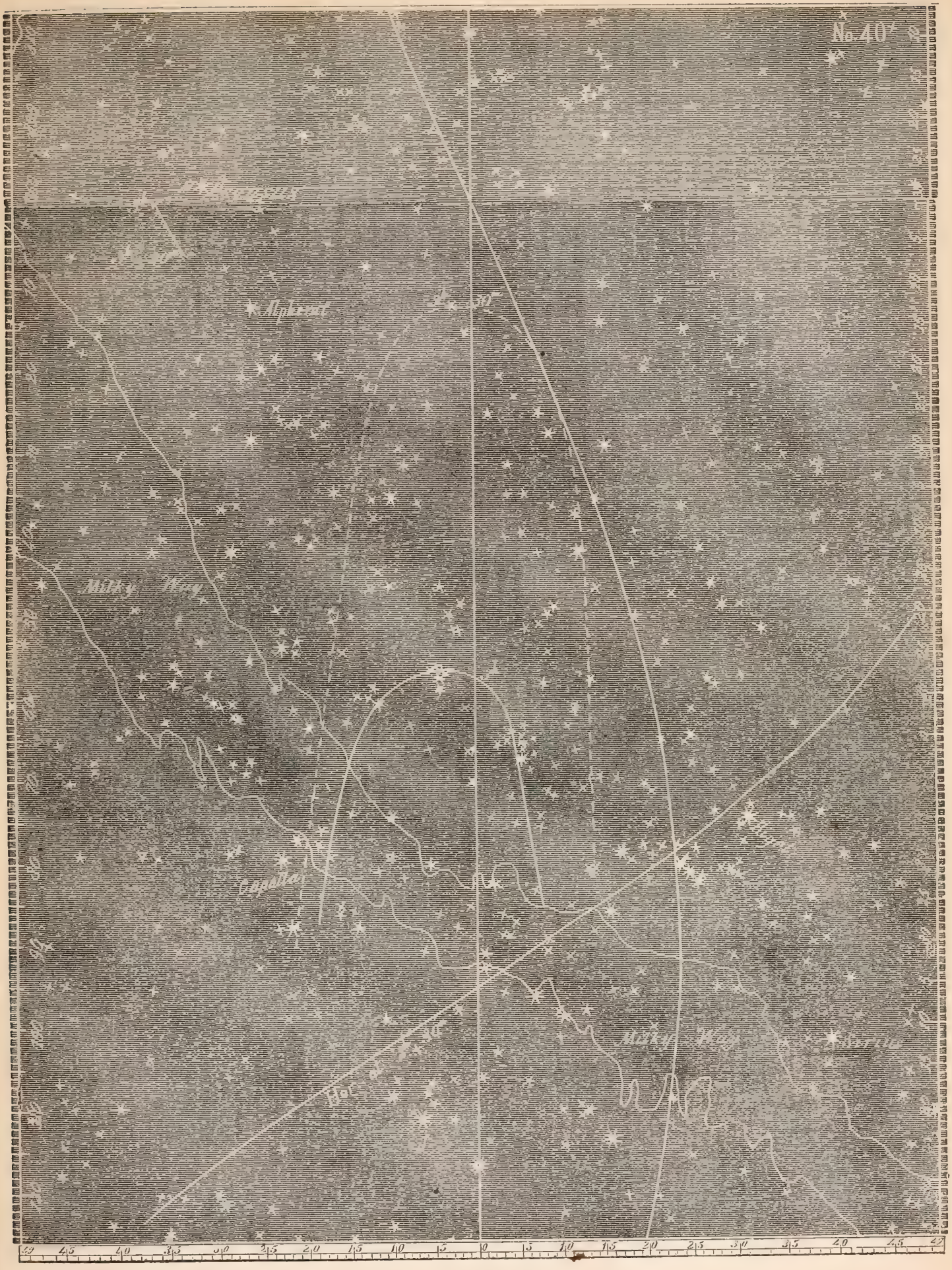

No. 39
Perseus
Algenib
Milky Way
Capella
Milky Way

No. 40.

JULY 19th, 1853: Morning.

Lat. at 3*h*., 32° 4′ N.: Lon. 135° 55′ E.
Sun rose 5*h*. 10*m*.
Stronger Light at 3*h*.: Diffuse Light, 3*h*. 30*m*.

Moon did not set till just after 3 o'clock. Was able, however, at 3^h, to get the boundaries of the Stronger Light; at $3^h\ 30^m$, got those of the Diffuse, as in the chart.

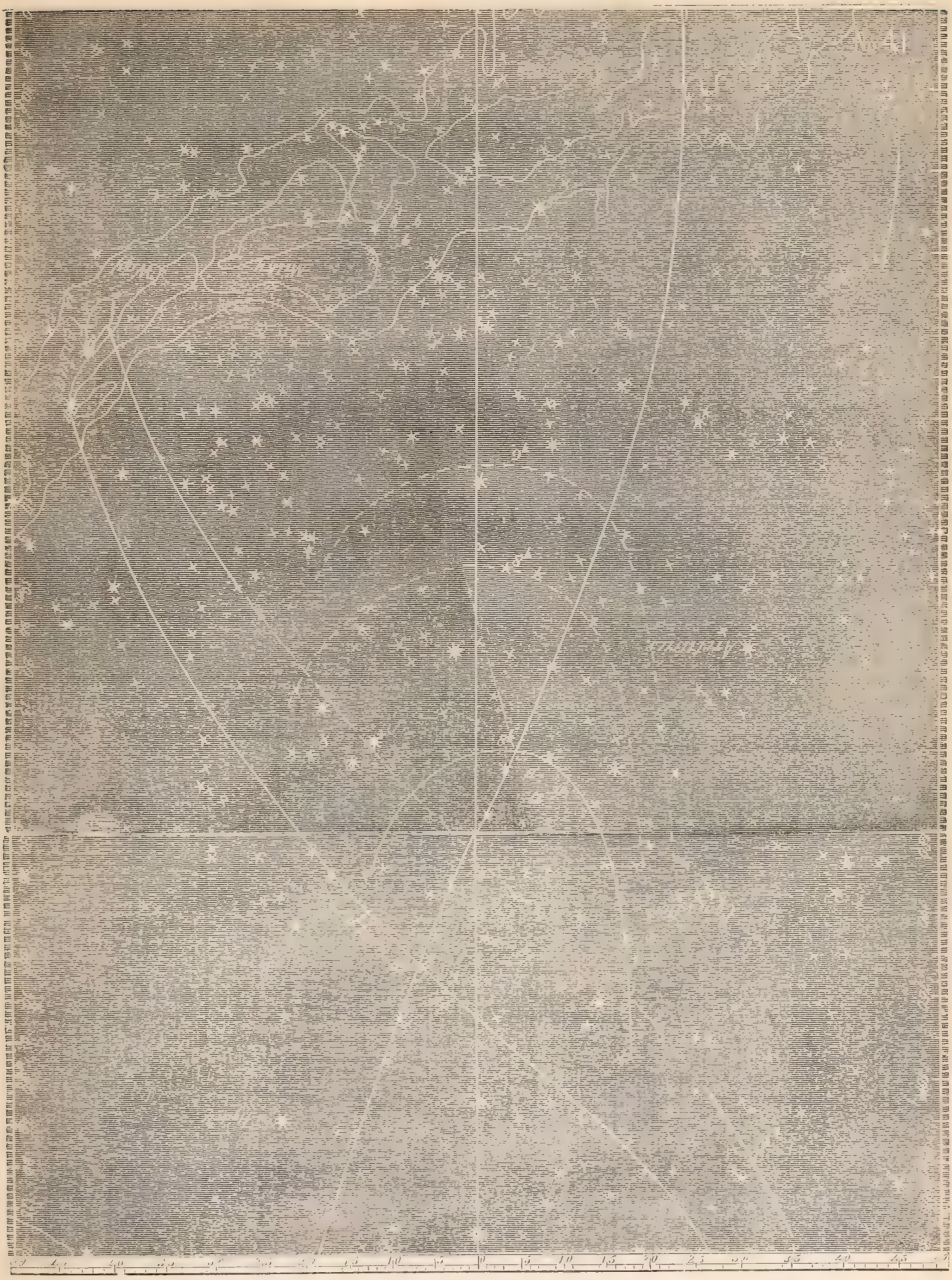

No. 40
Milky Way
Milky Way

No. 41.

AUGUST 4th, 1853 : Evening.

Latitude at 8*h*., 21° 45′ N.: Longitude 121° 33′ E.
Sun set 6*h*. 34*m*.
Stronger Light at 8*h*. : Diffuse Light at 8 and 9 o'clock.

Clouds since July 19th. This evening got observations. At 9^h, there was no Stronger Light, and all was very dim. At 8^h, the Light just below 43 and 39 Virginis (marked *a a a* in the chart), was equal to that of the Milky Way about 23 and 26 Scorpionis (marked in the chart by *b b b*).



No. 42.

AUGUST 5th, 1853: Morning; also Eastern Light the evening previous.

Lat. at 4 a. m., 21° 31′ N.: Lon. 121° 3′ E.

Sun rose 5*h*. 39*m*.

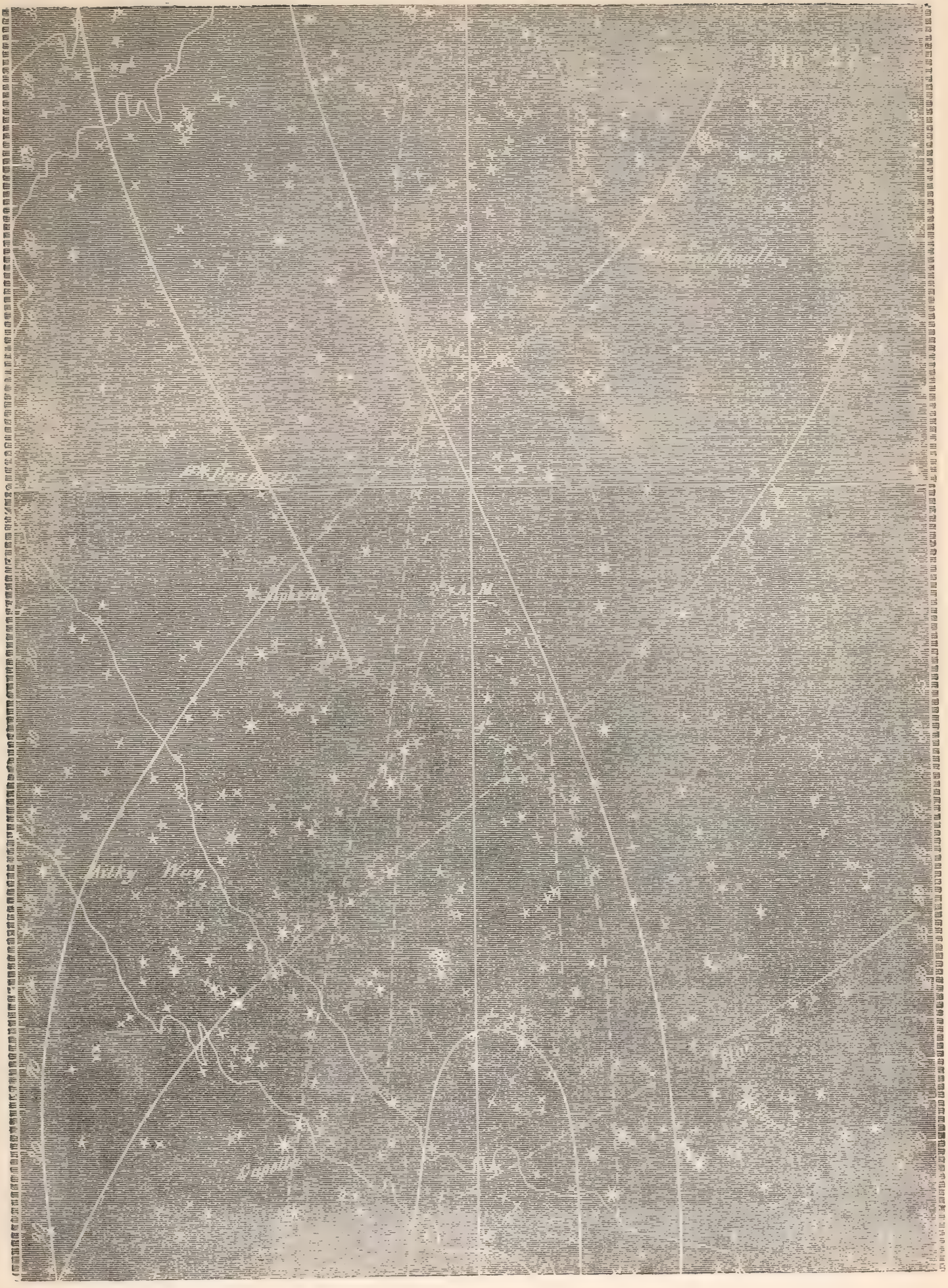
Stronger Light at 4*h*.: Diffuse, 8*h*. 30*m*. and 11*h*. p. m., of 4th, and 2*h*. and 5*h*. of 5th.

At 8^h 30^m, last evening, I turned to the eastward, and found there an appearance much like the upper extremity of the usual Zodiacal Light. Its boundaries are given in this morning's chart. Distrustful of my judgment, I got one of the quartermasters to look, who readily made it out and defined its boundaries—the same as they appeared to me. Its brightness was equal to that of the Milky Way about 16 Aquilæ (marked *a a a* at the upper end of the chart). It could not be confounded with the Milky Way, between which and it there was a decidedly dark space; as there was, also, on the other side of the Milky Way, between the latter and the top of the Western Zodiacal Light, then in sight.

At 11^h went on deck, and found the same appearance, only it had changed its place, and was larger, as in the chart; the brightness was about equal to that of half-past eight.

At 2^h, on deck again; and now the Zodiacal Light was very decided. There could be no mistake about it. At 4^h, another observation, and now had the Stronger Light. I cannot assert that the Eastern Light, at 8^h 30^m and 11^h p. m., was the real Zodiacal Light; but it was much like it.

[Brooklyn, 1856.—The above remarks, with others of previous date, on this Eastern Light, will show my exceeding caution about admitting any thing new, and my fears about embarrassing the true observations with any thing uncertain. A letter from me, published in May, ultimo, in the American Astronomical Journal, has led Baron Humboldt to quote from his unpublished MSS., in which are records of a similar light seen by him in the *east*, in the evenings of the 17th and 18th of March, 1803, in lat. about 13° N.; which, however, he supposes to be only a reflection from the Western Zodiacal Light, then shining with exceeding brilliancy. (See *Astronomische Nachrichten*, No. 989.) In No. 998 of the *Astro. Nachrichten*, is another paper on this subject by Mons. Theo. J. C. A. Brorsen, of Serptenberg, in Germany, who calls this Eastern evening light by the appropriate name of *gegenschein* (a shining opposite), and informs us that he had seen it regularly at that place during the two previous years. His paper concludes as follows: "The *gegenschein* is visible, not only at the vernal, but also at the autumnal equinox; at the former time more distinctly. A faint trace of it becomes visible in January, from which time it grows stronger till March, when, and in April and the early part of May, it is quite distinct and broad. A much smaller and weaker *gegenschein* appears in September, October, and November. I have become convinced, by frequently repeated observations, that, in both cases, the brightest part of the *gegenschein* is directly opposite the place of the sun; so that a calculation of the greatest light frequently coincides to a degree with the point of opposition to the sun. The observations proved that the vernal *gegenschein*, about the middle of April, joins the Westerly Zodiacal Light by a strip or belt of light, which is, at first, very weak, but becomes by degrees more luminous; the autumnal *gegenschein* appears, in the first part of November, to be elongated along the ecliptic by a weak zone of light as far as the western horizon, which zone of light is, by degrees, transformed, by increasing luminosity and more distinct basis, into the well-known phenomenon of the Western Zodiacal Light. From this time to the commencement of March, its apex remains almost stationary in the region of τ 1 and τ 2 Arietis. Both *gegenschein* could be seen here, at the same season, on every clear evening; and even distinctly in the light of the new moon."]

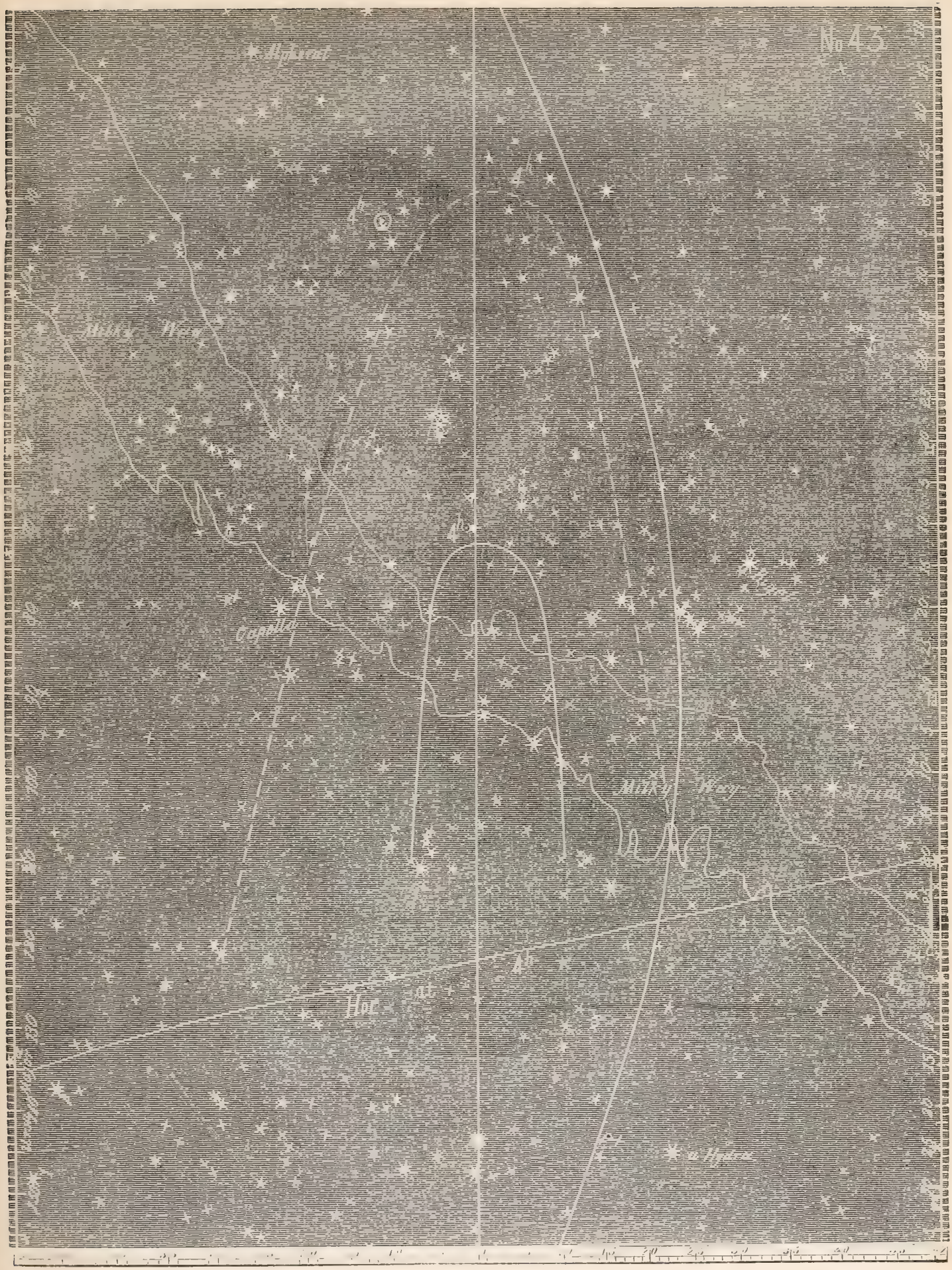

Milky Way

No. 43.

AUGUST 16th, 1853 : Morning.

Lat. 23° 2′ N. : Lon. 113° 28′ E.
Sun rose at 5*h*. 40*m*.
Stronger and Diffuse Light at 4 o'clock.

Since last date (5th instant), have had unbroken cloudy weather (except one night, which was hazy), until last evening. Then the moon interfered. Rose at 4^h this morning, and took boundaries as in the chart.

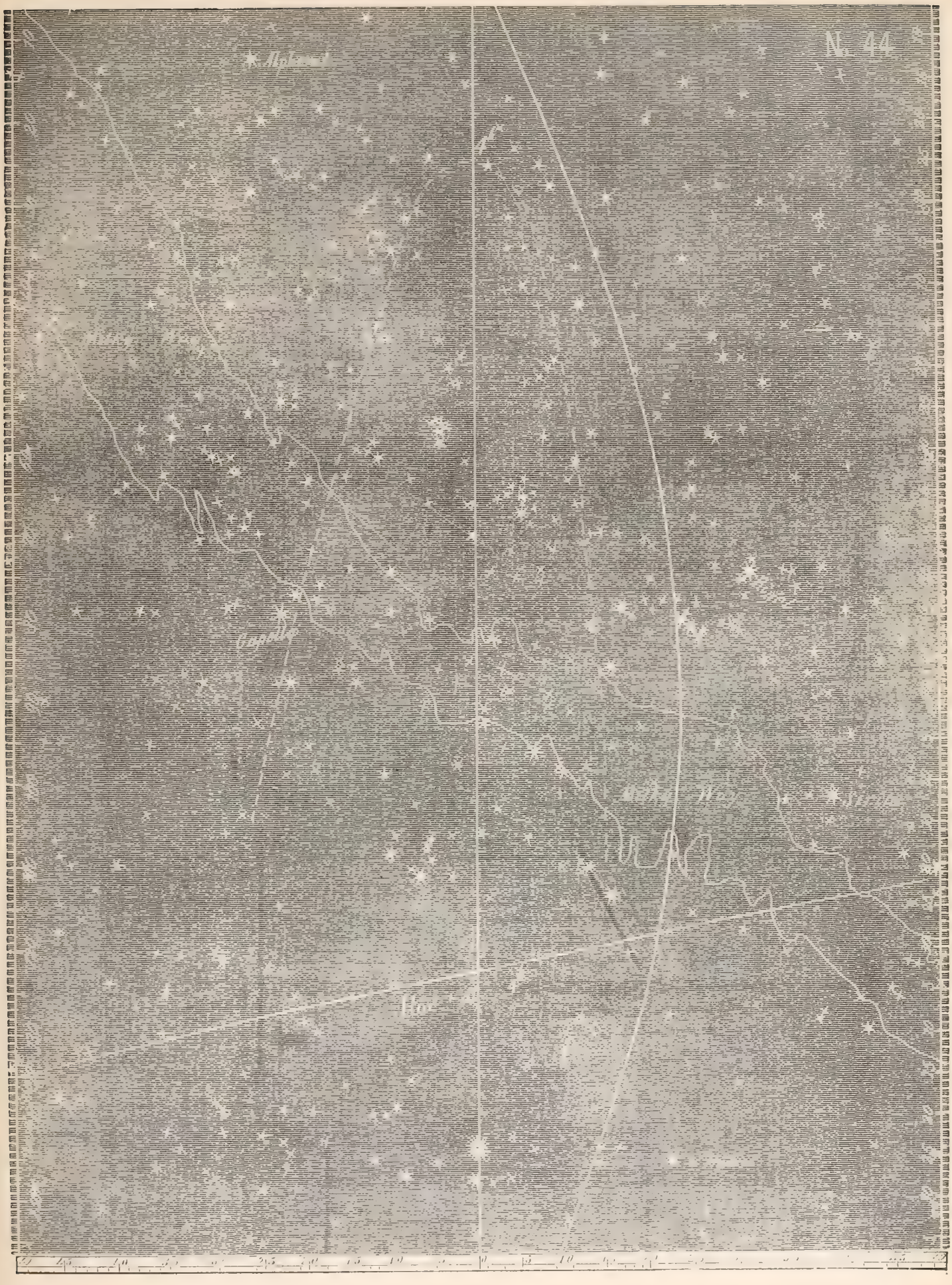

No 43
Milky Way
Capella
Milky Way
Hor
α Hydræ

No. 44.

AUGUST 17th, 1853: Morning.

Lat. 23° 2′ N.: Lon. 113° 28′ E.
Sun rose 5*h*. 42*m*.
Diffuse Light at 4 o'clock.

The Stronger Light appeared to have the same boundaries as yesterday morning; but, before I could take them, clouds filled up that part of the sky; nor could I afterwards have any observation.

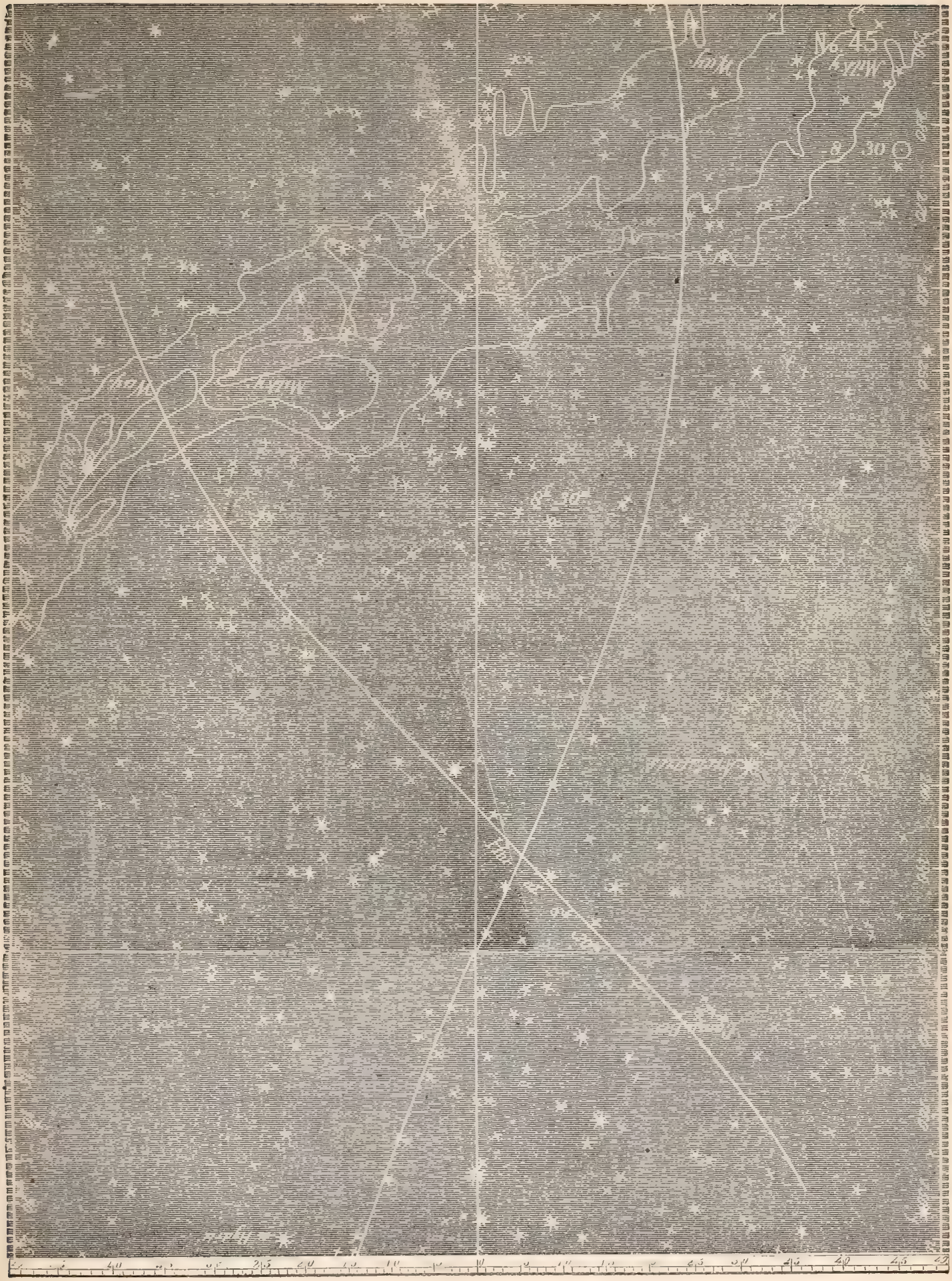

N. 44

No. 45.

AUGUST 26th, 1853 : Evening.

Lat. 23° 2′ N.: Lon. 113° 28′ E.
Sun set 6*h*. 19*m*.
Diffuse Light at 8*h*. 30*m*.

Clouds since last date (17th). Prevented this evening, by the same cause, from observations till $8^h\ 30^m$, when the sky cleared, and I had the Zodiacal Light as in the chart.


No. 45
30

No. 46.

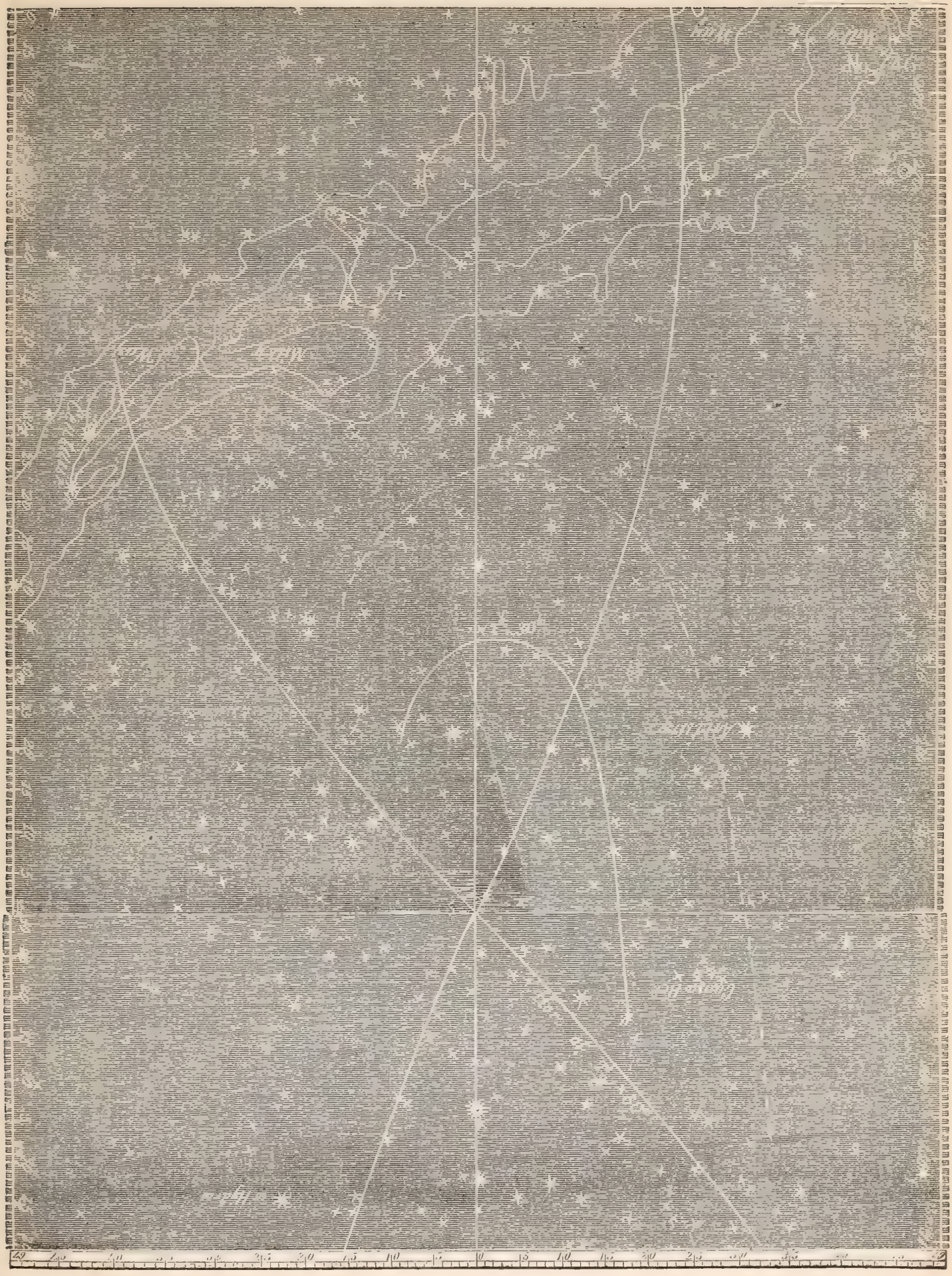
AUGUST 29th, 1853: Evening.

Lat. 23° 2′ N.: Lon. 113° 28′ E.

Sun set 6*h*. 16*m*.

Stronger and Diffuse Light at 7*h*. 30*m*.

Both the Stronger and Diffuse Lights are now much fainter than they formerly were.

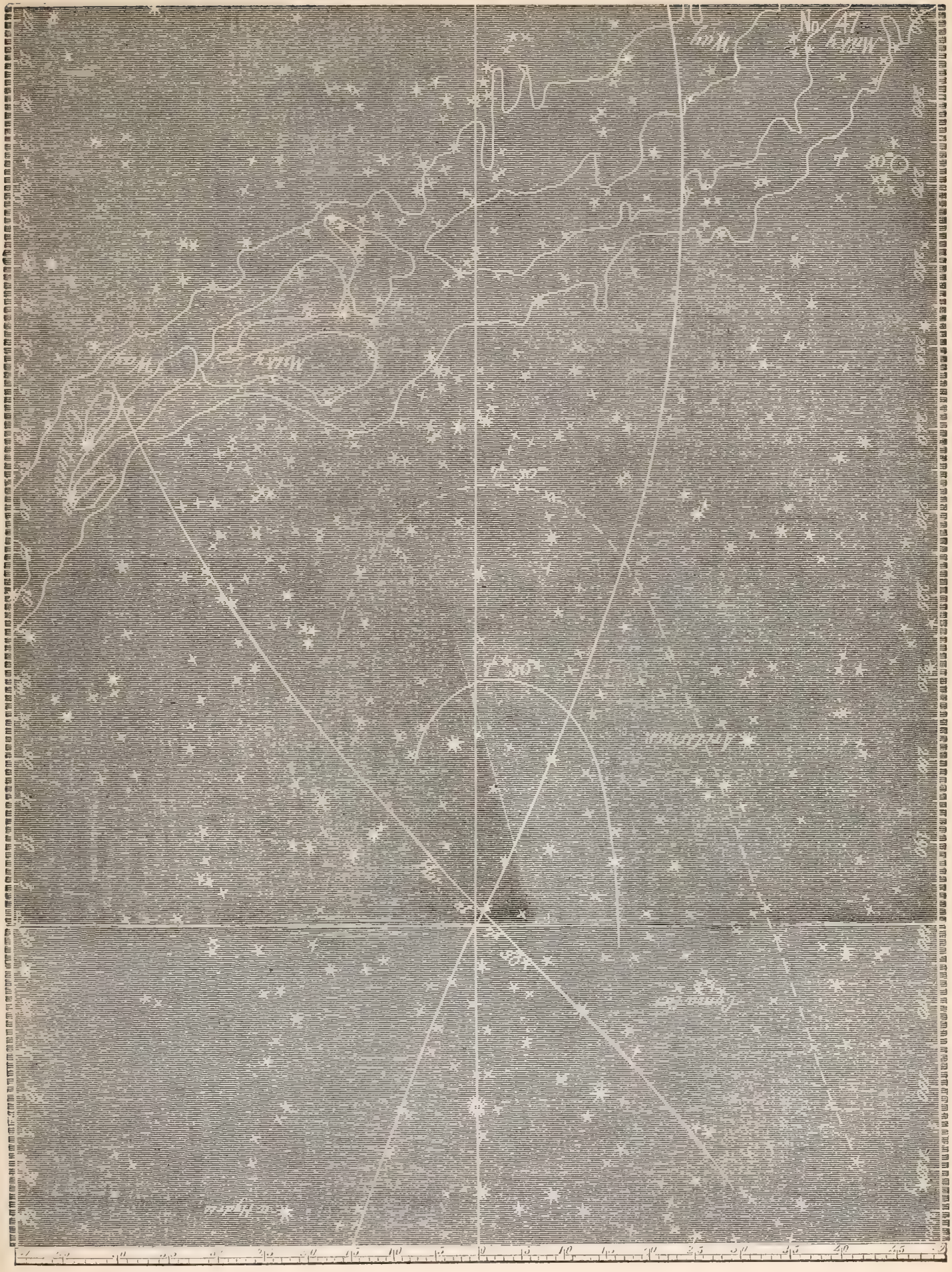


No. 47.

AUGUST 31st, 1853: Evening.

Lat. 23° 2′ N.: Lon. 113° 28′ E.
Sun set 6*h*. 15½*m*.
Stronger and Diffuse Light at 7*h*. 30*m*.

Nothing remarkable this evening; for the observation, see the chart.



No. 48.

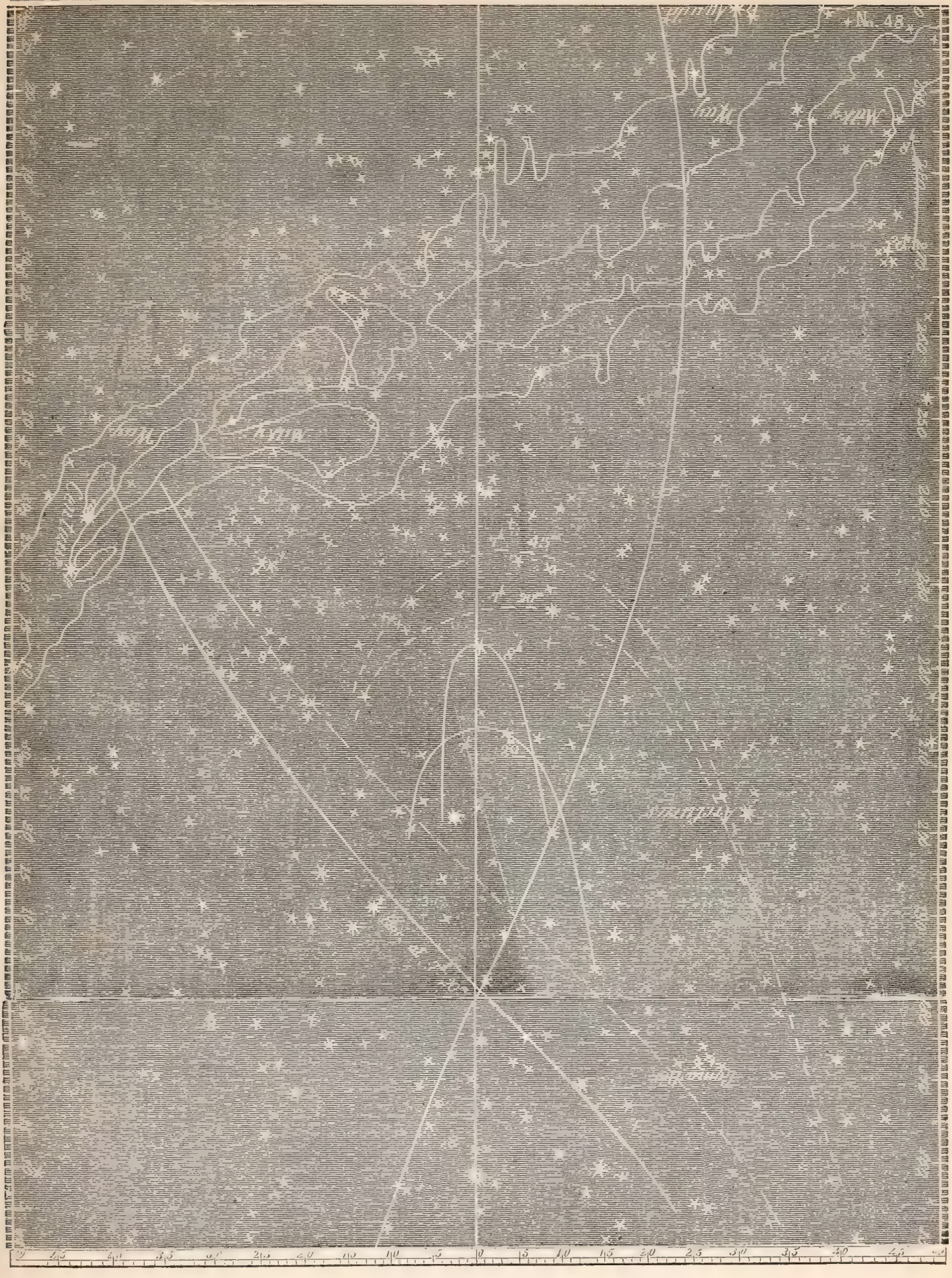
SEPTEMBER 1st, 1853 : EVENING.

Lat. 23° 2′ N.: Lon. 113° 28′ E.

Sun set 6*h*. 14*m*.

Stronger Light { 7*h*. 20*m*. / 7 45 / 8 0 } Diffuse, 7*h*. 20*m*. / 8 0

Took boundaries as in the chart.



No. 49.

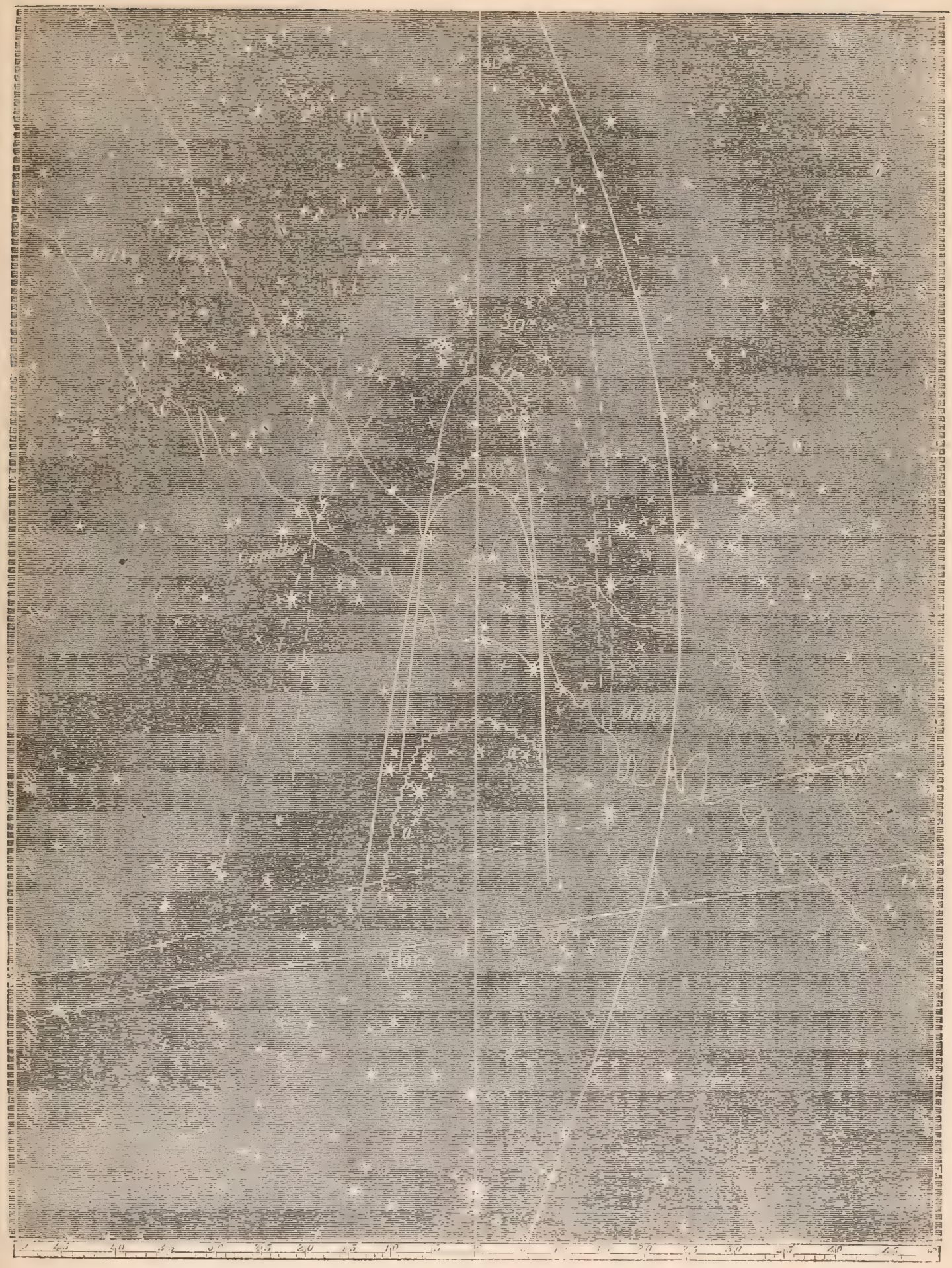
SEPTEMBER 2d, 1853 : Morning.

Lat. 23° 2′ N. : Lon. 113° 28′ E.
Sun rose 5*h*. 45*m*.
Stronger and Diffuse Light at 2*h*. 40*m*. and 3*h*. 30*m*.
Effulgent Light at 3*h*. 54*m*

The moon now, once more, admits of morning observations of the Zodiacal Light. At $2^h\ 40^m$ this morning, it was already very distinct.

At $3^h\ 54^m$, the Stronger Light became, almost suddenly, much stronger than before; the limits of this new effulgence being at the zigzag line *a a*. I supposed, at the time, that this was owing to the moon, then near its rising; but when the moon showed itself, at $4^h\ 18^m$, I saw that its light was too faint to produce such a result. At $4^h\ 30^m$, the light spread laterally, and dawn had come.

[1856.—I afterwards became familiar with this effulgent light, as the book will show, *passim*.]


Milky Way
Milky Way
Hor.

No. 50.

SEPTEMBER 3d, 1853: Morning.

Lat. 23° 2′ N.: Lon. 113° 28′ E.

Sun rose 5*h*. 46*m*

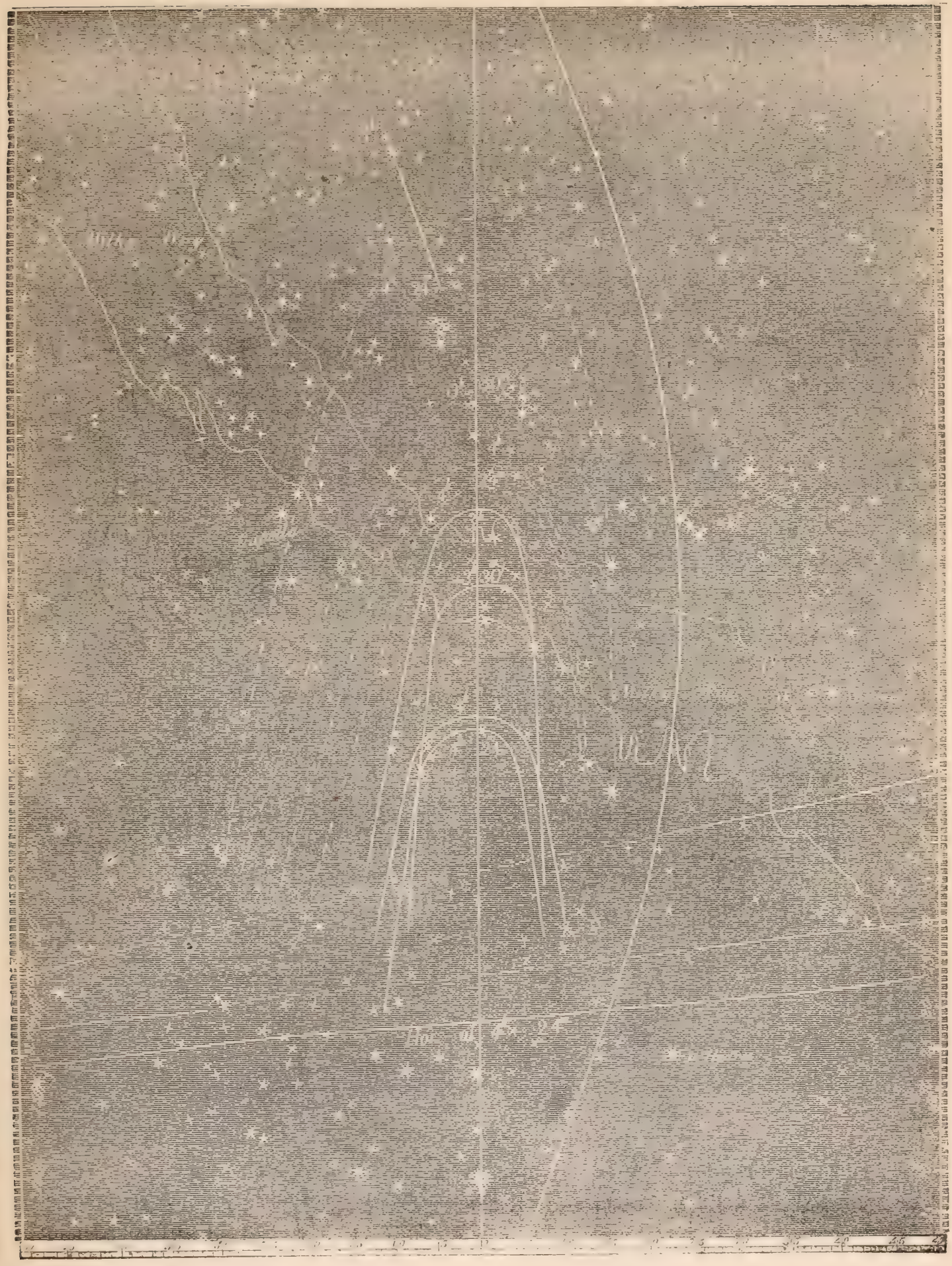
Stronger and Diffuse Light at 3*h*. 0*m*.

3 30

4 0

4 24

Cloudy last evening. Had fine observations this morning; sky perfectly clear quite to the horizon. The Light was strongest at $3^h\ 30^m$; dawn at $4^h\ 30^m$.

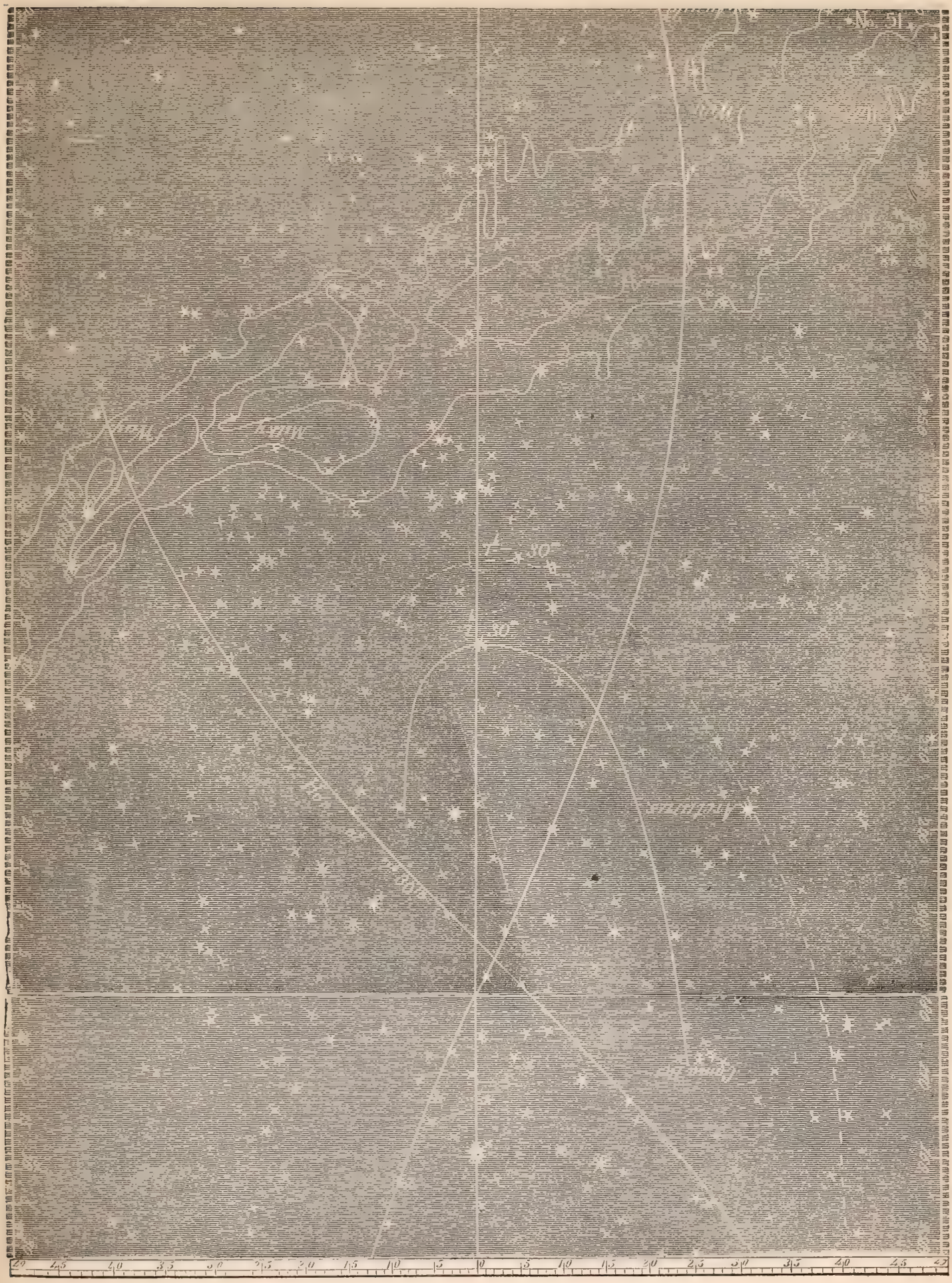


No. 51.

SEPTEMBER 3d, 1853 : Evening.

Lat. 23° 2′ N.: Lon. 113° 28′ E.
Sun set 6*h*. 12*m*.
Stronger and Diffuse Light at 7*h*. 30*m*.

Had good observations of the Zodiacal Light. At $8^h\ 30^m$ it was still visible, but too faint to give a reliable outline.



No. 52.

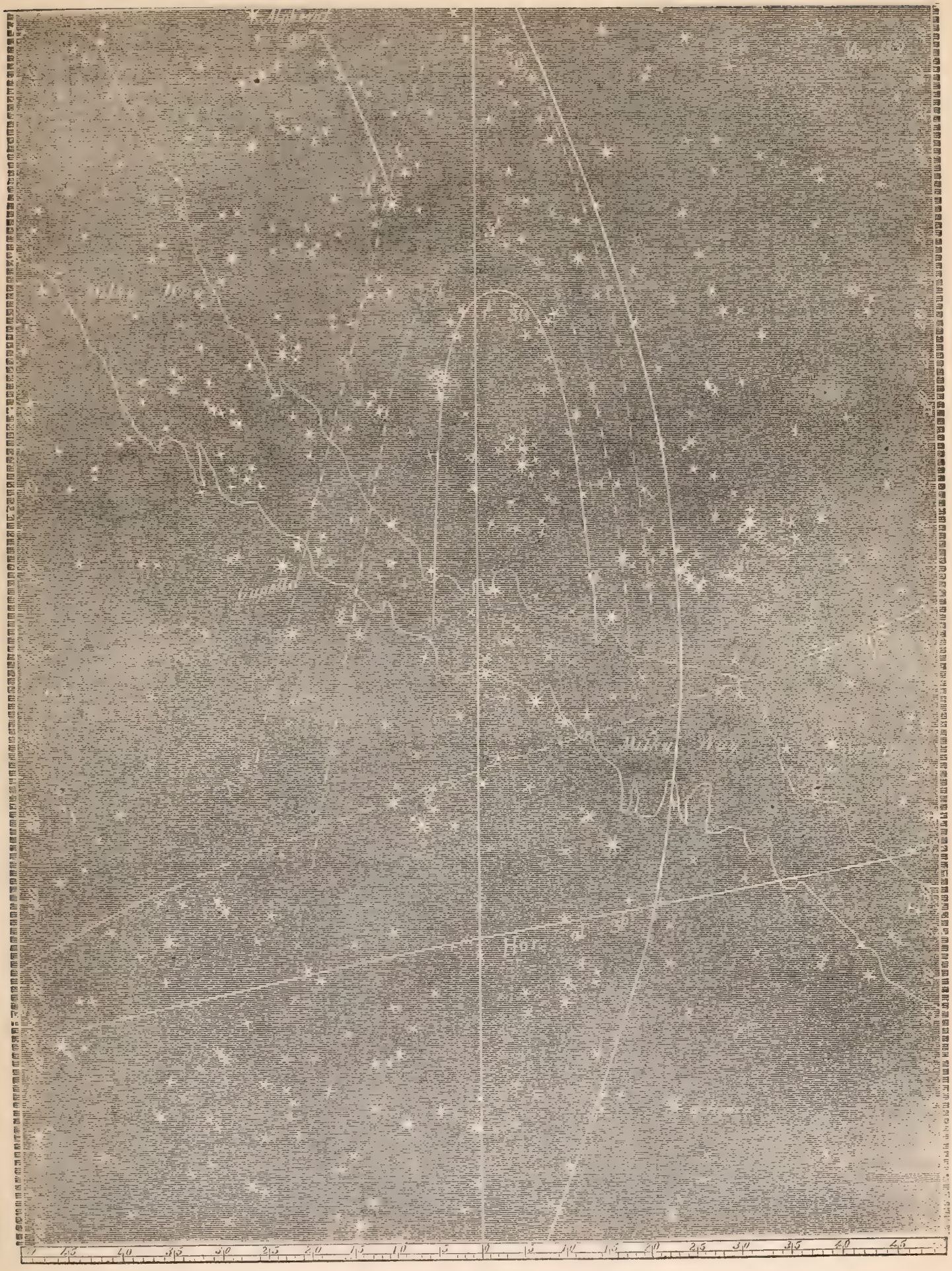
SEPTEMBER 5th, 1853: MORNING.

Lat. 23° 2′ N.: Lon. 113° 28′ E.

Sunrise 5h 17.7m

Stronger Light 1h 59.7m. Diffuse 1h 33.7m and 3h

Rose early for observations. At 1h 30m the Light was very distinct; both the Diffuse and the Stronger Limits. At 3h, clouds prevented my getting boundaries of the Stronger Light.



No. 53.

SEPTEMBER 12th, 1853 : Morning.

Lat. 23° 2′ N. : Lon. 113° 28′ E.

Sun rose 5*h*. 19*m*.

Stronger Light 4*h*. 0*m*. and 4*h*. 24*m*. Diffuse Light 4*h*.

Clouds since the 5th; moon also in the evening. This morning had good observations at 4^h, and $4^h\ 24^m$. At $4^h\ 24^m$ dawn had already commenced, and was too strong to allow me to get the limits of the Diffuse Light.

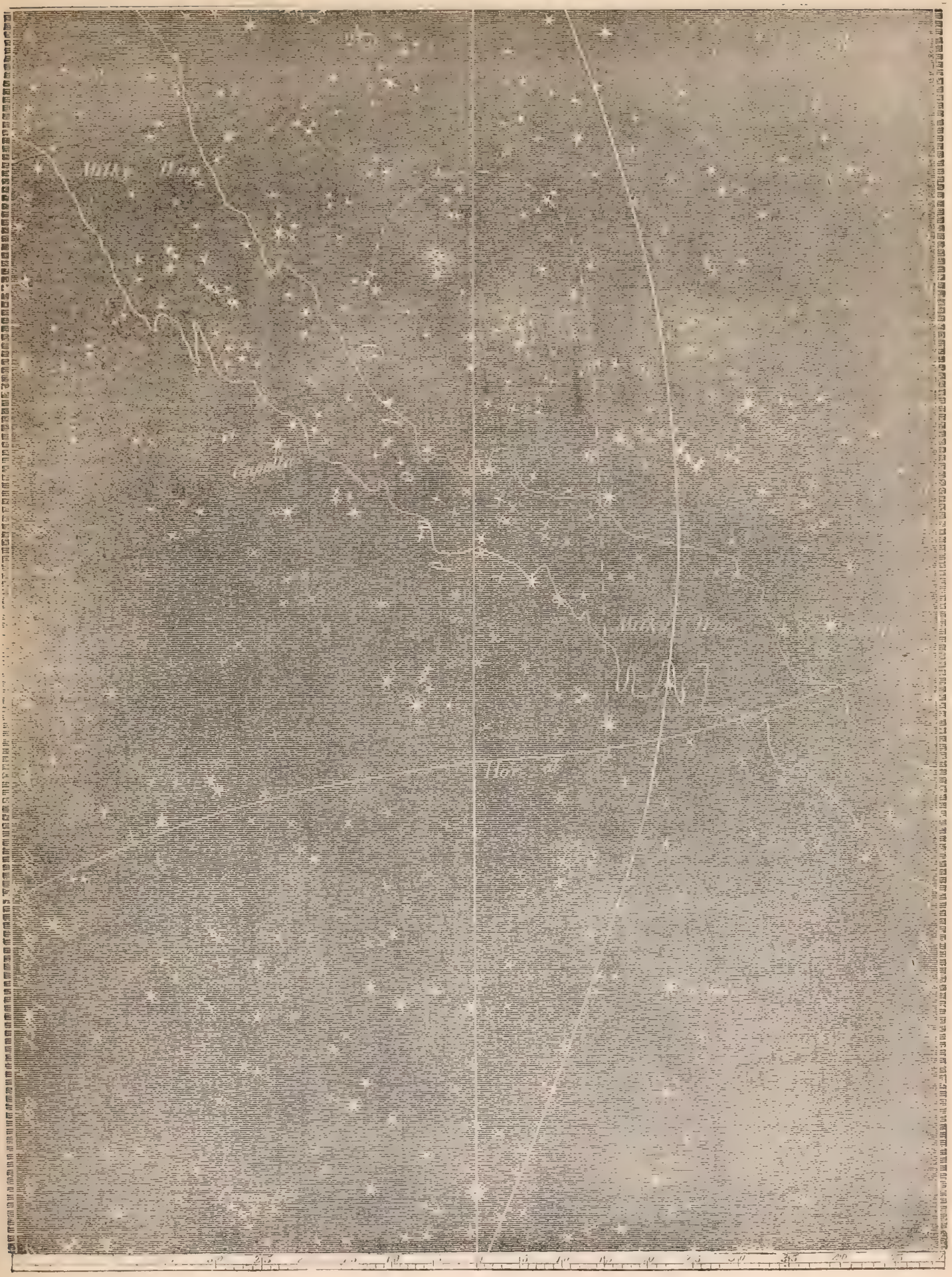
N
Milky Way
Capella
Milky Way
Hydra

No. 54.

SEPTEMBER 13th, 1853 : Morning.

Lat. 23° 2′ N.: Lon. 113° 28′ E.
Sun rose 5*h*. 49*m*.
Diffuse Light at 2 o'clock.

Got an observation at 2 o'clock, only for the Diffuse Light. I had to struggle, for this, with the clouds, which soon after put a stop to all further observations.



No. 55.

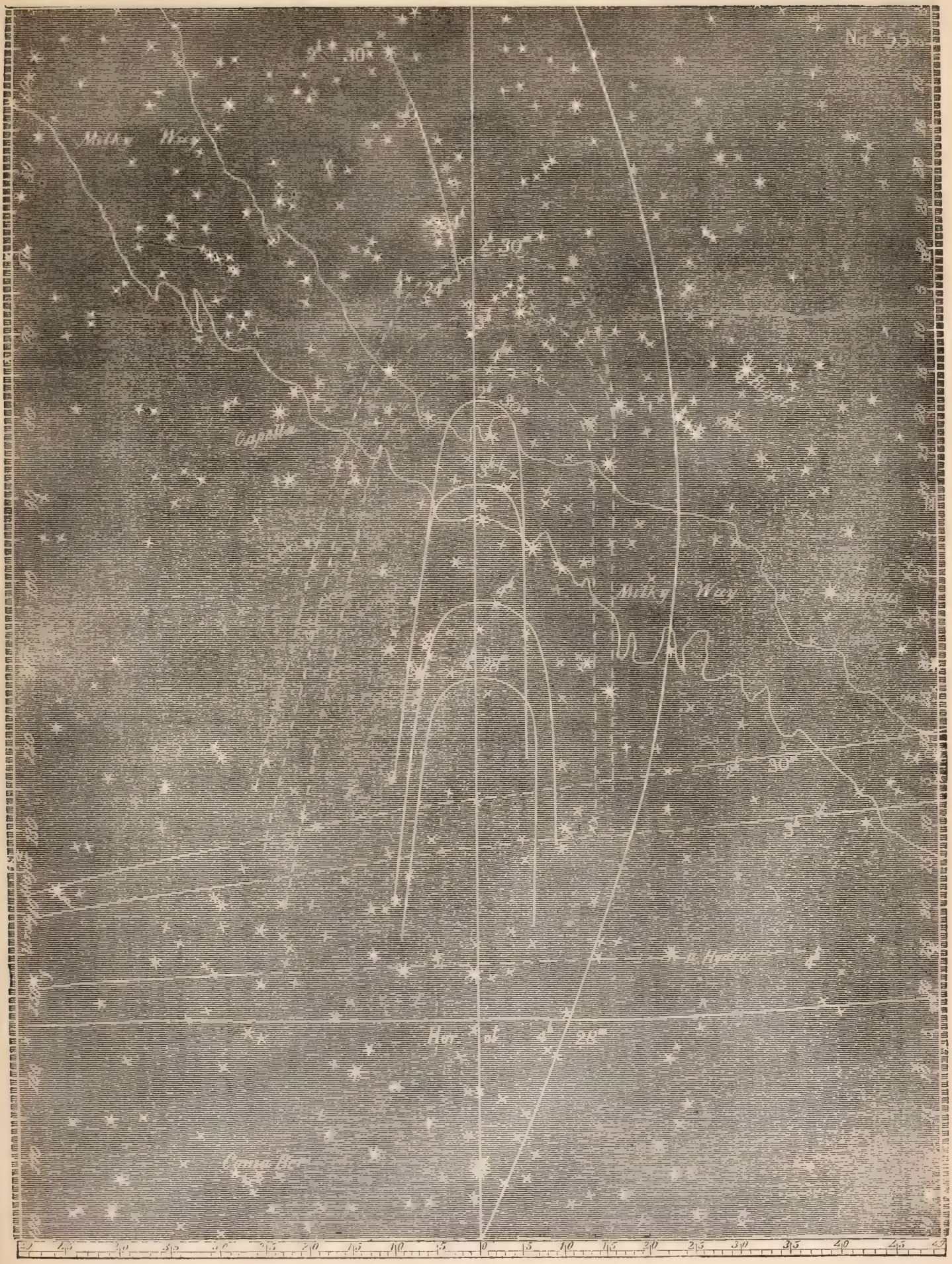
SEPTEMBER 14th, 1853 : MORNING.

Lat. 23° 2′ N.: Lon. 113° 28′ E.

Sun rose 5*h* 49½*m*.

Stronger Light 2*h*. 30*m*.		Diffuse 2*h*. 30*m*.	
3	0	3	0
4	0	4	0
4	28		

Moon set about $2^h\ 30^m$. From that time on, had *excellent* observations, the atmosphere being remarkably clear. At $4^h\ 28^m$ dawn had advanced so as to overpower the Diffuse Light. The Stronger Light was remarkably bright just before dawn.


Milky Way
Capella
Milky Way
Hydra
Coma Ber.

No. 56.

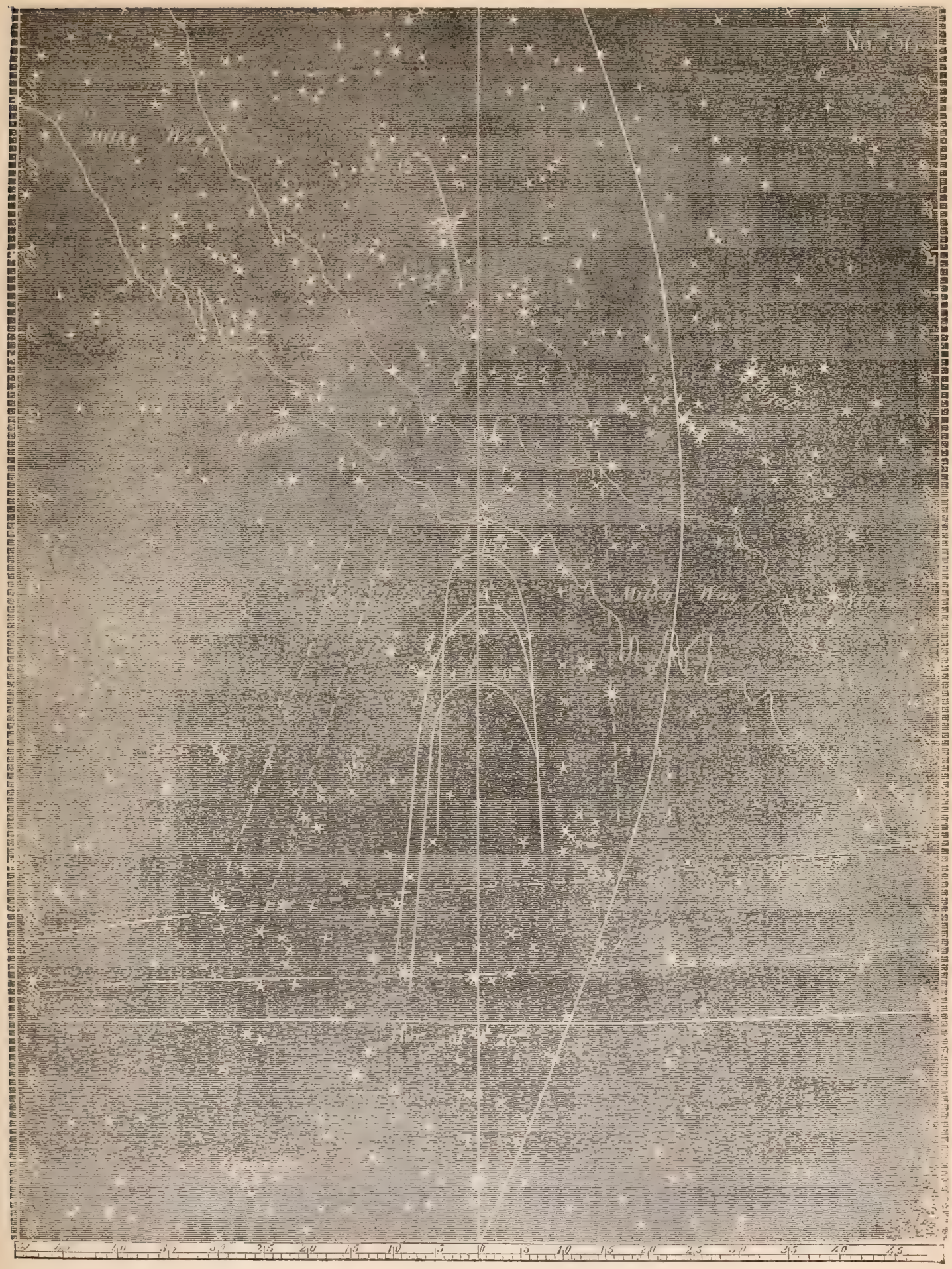
SEPTEMBER 15th, 1853 : Morning.

Lat. 23° 2′ N. : Lon 113° 28′ E.

Sun rose 5*h*. 50*m*.

Stronger Light 3*h*. 15*m*.	Diffuse Light 3*h*. 15*m*.
4 0	4 0
4 20	
4 26	

Moon set at 3^h 15^m. Had a *good* observation immediately afterwards, and also at 4^h. At 4^h 20^m, the Diffuse Light was too faintly marked to give a reliable outline. The Stronger Light now becomes more and more intense till just before dawn; then it begins to spread laterally; finally, it gradually melts into the dawn. I noticed this morning, that this lateral spreading is more rapid and greater towards the N. than towards the S.; its boundaries at 4^h 26^m are marked by the dotted line: at 4^h 30^m it was merged into dawn.

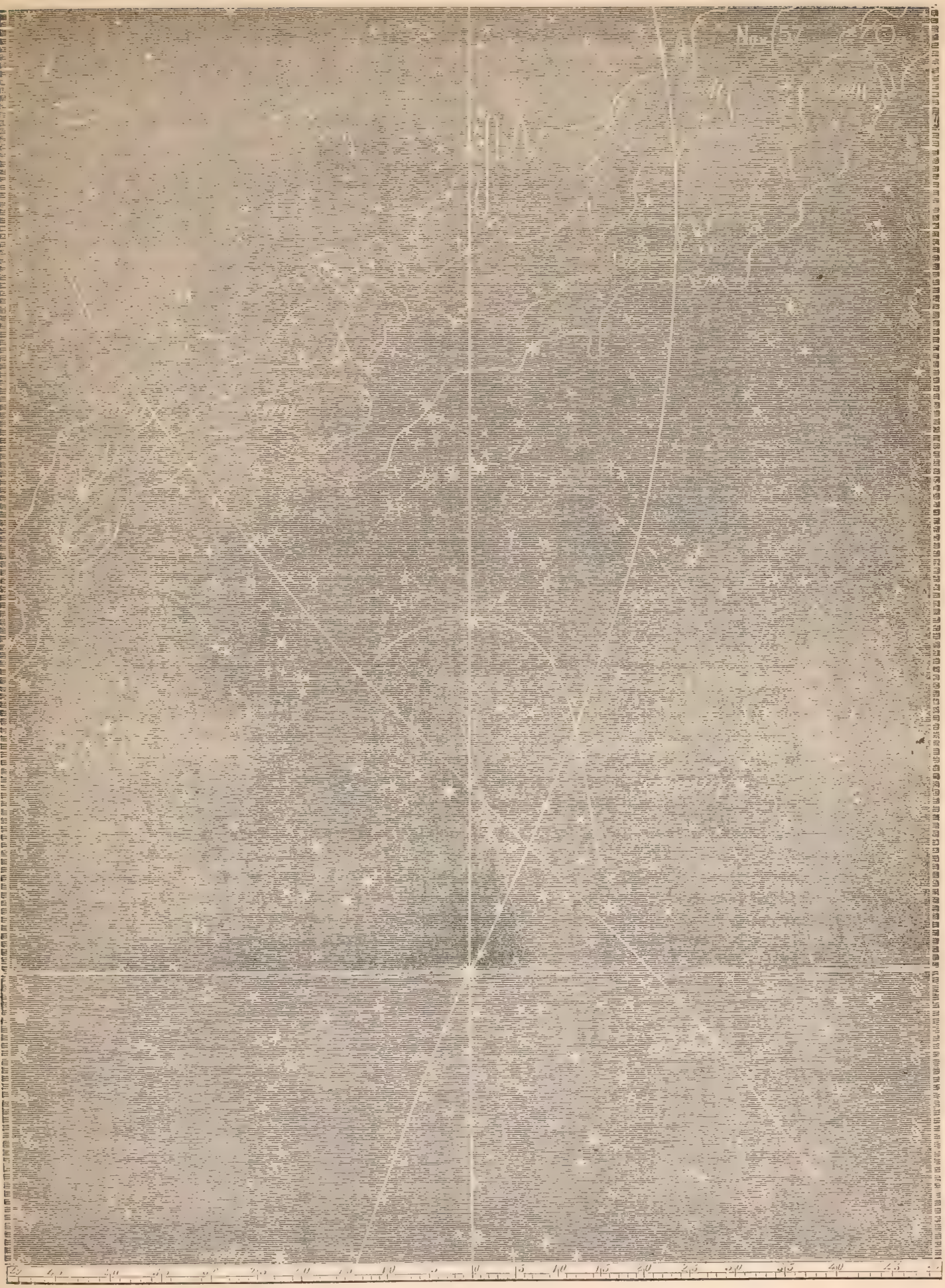

No. 5(a)
Milky Way
Milky Way

No. 57.

SEPTEMBER 24th, 1853 : Evening.

Lat. 23° 2′ N. : Lon. 113° 28′ E.
Sun set 5*h*. 50*m*.
Stronger and Diffuse Light at 7 o'clock.

Moon in the morning; clouds uniformly in the evening since last date. This evening, had a clear atmosphere and a very good time for observation. The evening Zodiacal Light now, though not showy, is extremely interesting; as it presents itself broadside to us, and offers a good opportunity of ascertaining its northern limits. These appear to be about 45° from the ecliptic. The Stronger Light is not striking, owing to its proximity to the horizon.



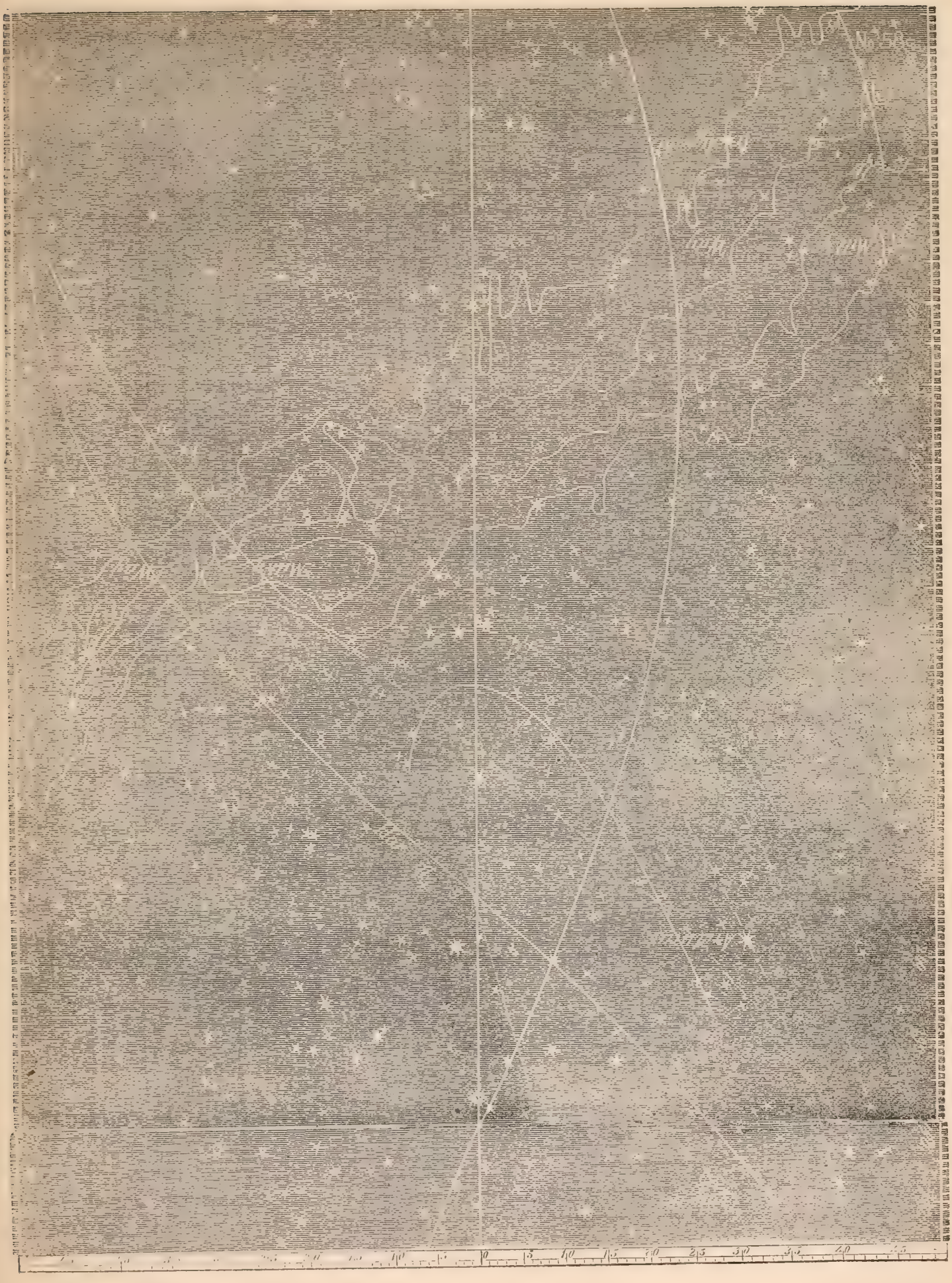
No. 58.

SEPTEMBER 27th, 1853 : Evening.

Lat. 23° 2′ N. : Lon. 113° 28′ E.
Sun set 5*h*. 48*m*.

Stronger Light 7*h*.	Diffuse Light 7*h*.	0*m*.
	7	30
	8	0

Had good observations this evening, the sky being very clear; and, as they are important at the present time, as showing the northern limits of the Zodiacal Light, I observed with particular care. The Light is not strong, and the outlines are not very decided; but I believe I have, in consequence of great care, been able to get them correctly. At 8^h, the full boundaries of the Diffuse Light could not be had reliably. The Stronger Light, at 7^h, was not very decided; and this Light, in consequence of its proximity to the horizon, or from some other cause, is not as strong as formerly.



No. 59.

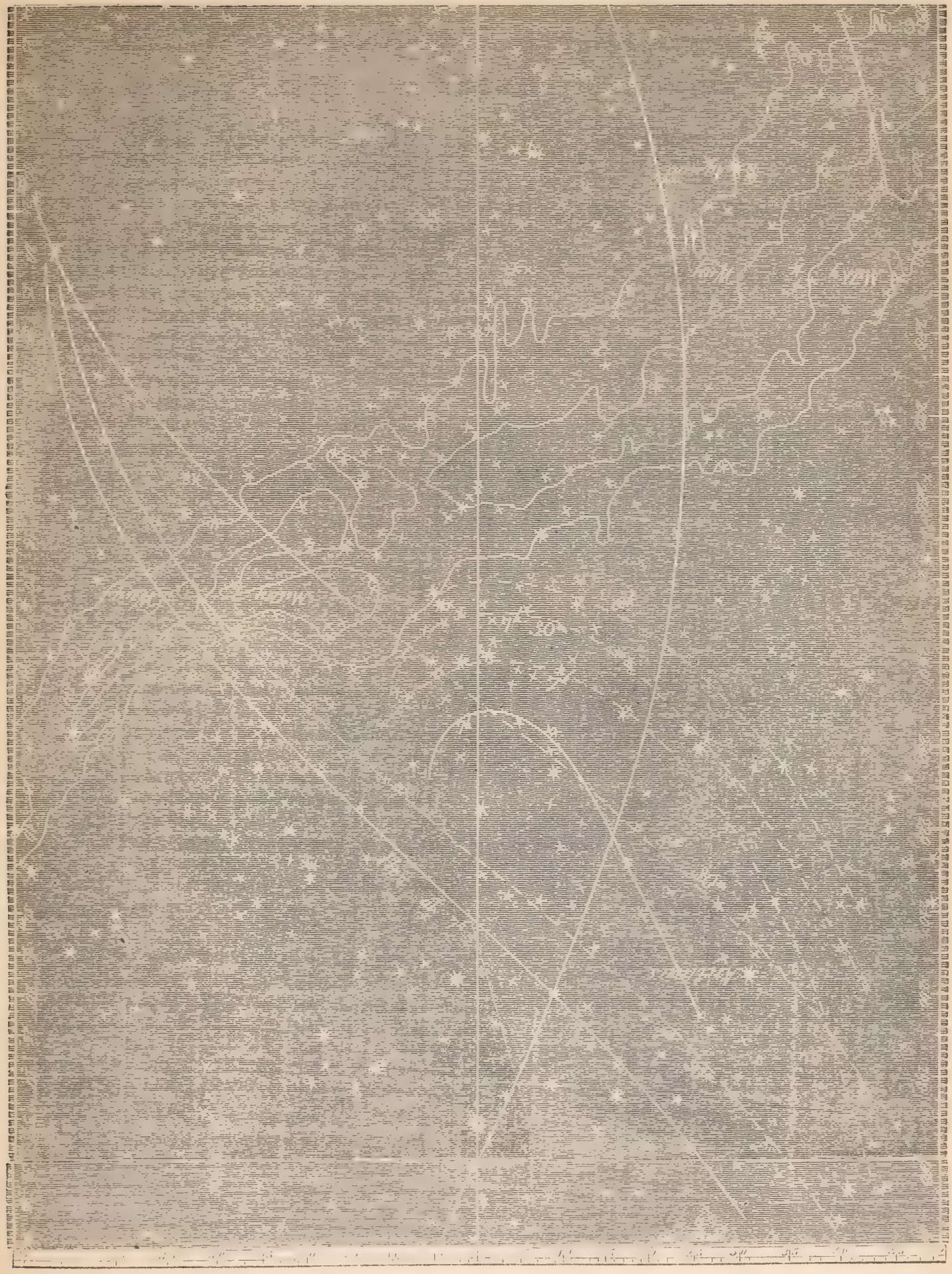
SEPTEMBER 28th, 1853 : EVENING.

Lat. 23° 2′ N.: Lon. 113° 28′ E.

Sun set at 5*h*. 47½*m*.

Stronger Light at		Diffuse at	
		7*h*.	0*m*.
		7	30
		8	0
		8	30

Had observations, for which see chart. At 8ʰ 30ᵐ, the upper end of the Diffuse Light was still well defined; but, at its lower, or right-hand extremity, I could not get reliable boundaries.



No. 60.

SEPTEMBER 30th, 1853: Morning.

Lat. 22° 23′ N.: Lon. 113° 32′ E.
Sun rose 5*h*. 55*m*.
Stronger Light at 3*h*. 0*m*. Diffuse at 2*h*. 0*m*.
2 30
3 0

The sky, this morning, was remarkably clear—so clear, that I could easily see stars of the 6th magnitude with the naked eye. Rose at $1^h\ 30^m$, and was on deck till the moon showed itself, near half-past 3. Observed very carefully, in order to see at what time the Zodiacal Light would first show itself. It was at two o'clock that I could first make it out: it was dim. At $2^h\ 15^m$, it was decidedly exhibited; at $2^h\ 30^m$, the Stronger Light developed itself, and at 3^h, it was strong enough to give me its outlines reliably. As the moon was now approaching the horizon, I watched to see whether it would increase the brightness of the Zodiacal Light, and was pretty well satisfied that it did. The Zodiacal Light changed gradually from its former soft color into a hard white, and grew brighter and brighter—the limits of the new brightness keeping between 11 and 16 Hydræ, and 48 Cancri—till just before the moon rose, when they suddenly expanded along the horizon. The unilluminated part of the moon (which was uppermost) was so bright as to show itself most distinctly. Query: whence came the light illuminating that portion of the moon so greatly?

[P. S., 1856.—Was it from the Zodiacal Light?]

No. 61.

SEPTEMBER 30th, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

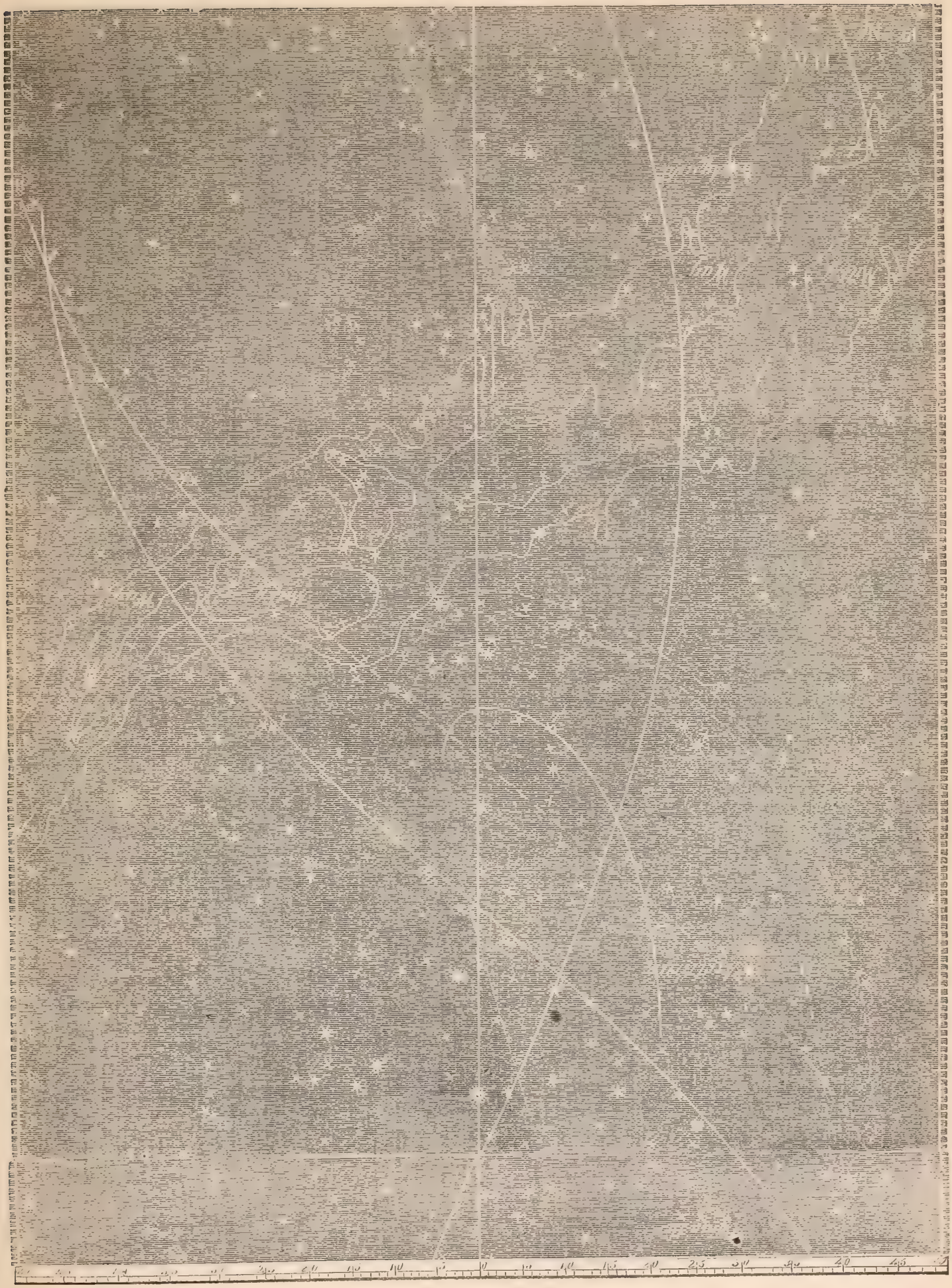
Sun set 5*h*. 45*m*.

Stronger Light at 7*h*. 0*m*. Diffuse Light at 7*h*. 0*m*.

7 30

8 0

Had a very good evening for observations. The Stronger Light is now greatly dimmed by haziness at the horizon. Noticed carefully to see at what time the Light could no longer be seen. At 8^h30^m, it was still distinct; but I could not get its limits reliably. At 9^h, I rather thought I could make it out; but there was no longer any certainty about it.

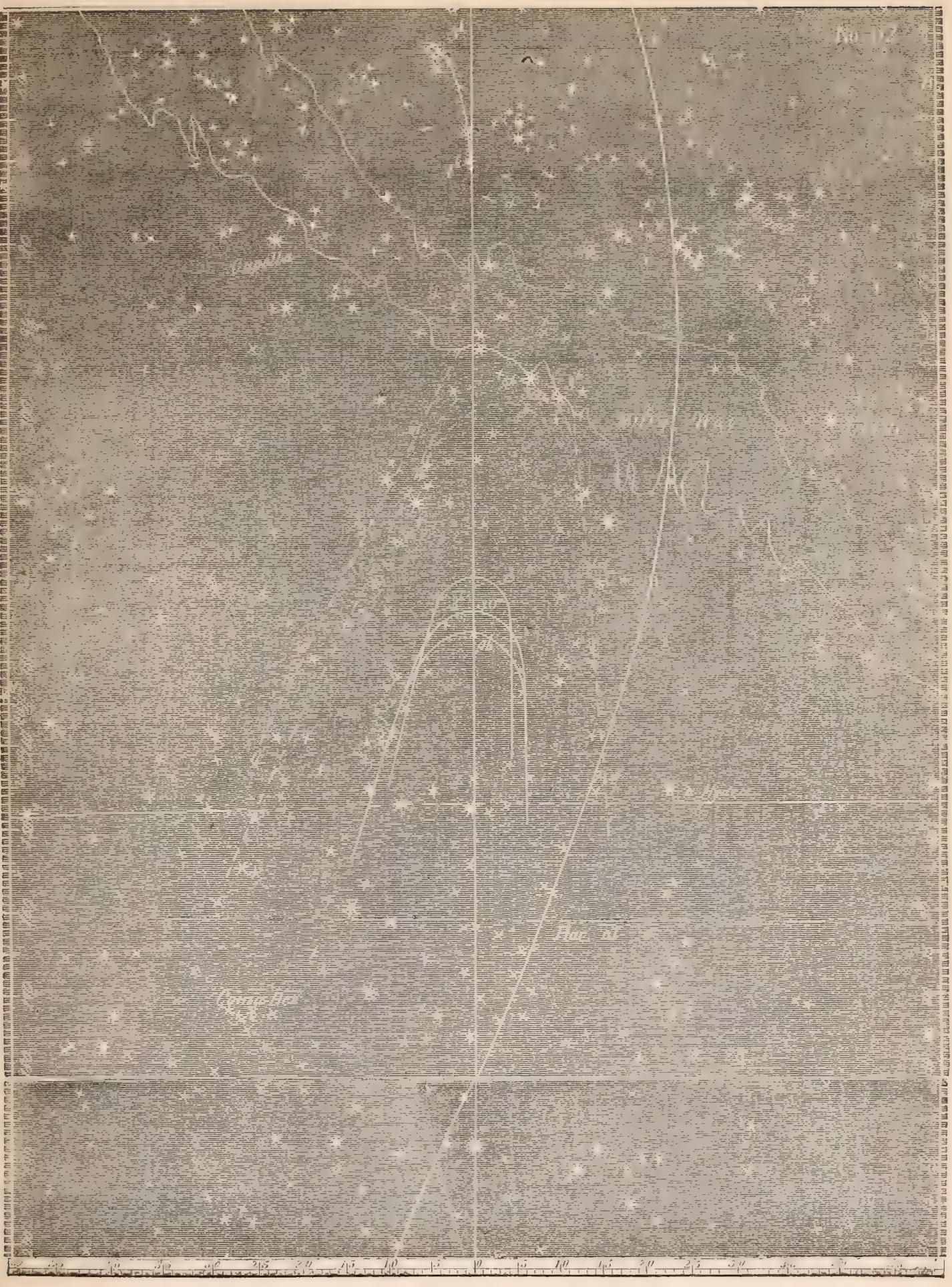


No. 62.

OCTOBER 1st, 1853 : MORNING.

Lat. 22° 23′ N.: Lon. 113° 32′ E.
Sun rose 5*h*. 55*m*.
Stronger and Diffuse Light at 3*h*. 0*m*.
3 30
4 0

Rose before 3^h, and had good observations till the moon came. At 3^h, the head of the Diffuse Light was lost in the Milky Way, and I could not make it out. Watched again to see what effect the approach of the moon would have. At 3^h 30^m, the central (Stronger) Light was bright. It then soon began to increase in strength, and to change its color from a soft white with a little tinge of yellow, into a hard steel white; the whiteness went on increasing, and the Light grew in intensity; also widening, but still keeping within the bounds of the Diffuse Light, till, suddenly, it spread generally over the face of the eastern sky, and the Zodiacal Light was over. The moon soon after appeared above the horizon.



No. 63.

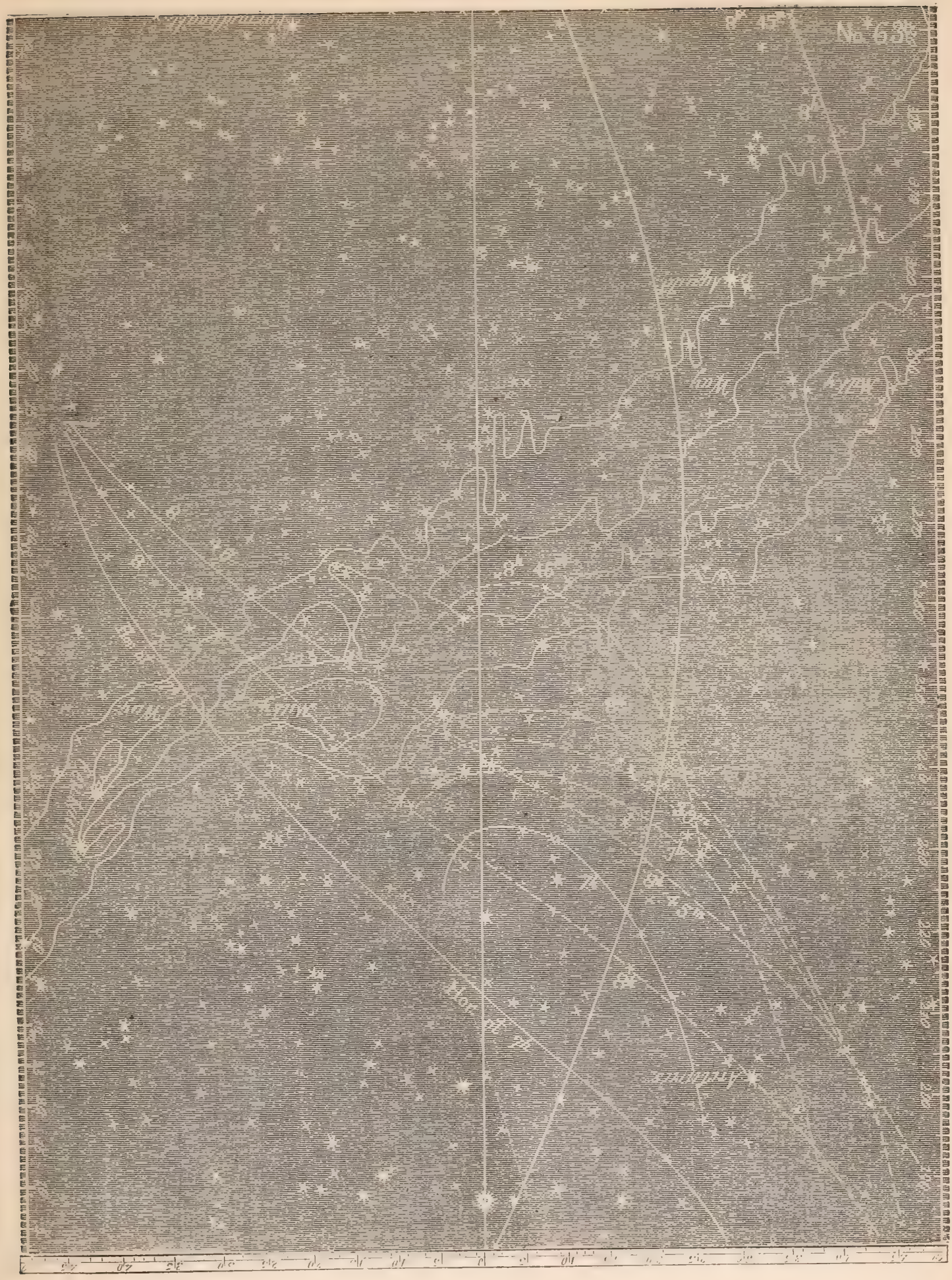
OCTOBER 1st, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun set at 5*h*. 44*m*.

Stronger Light at 7*h*. 0*m*.	Diffuse at 7*h*. 0*m*.
	7 30
	8 0
	8 45

Had a fine evening for observing the Zodiacal Light. At 9^h, it was very faint, but seemed to have the same limits as at 8^h 45^m. At 9^h 15^m, nothing could be made out. Last evening I drew lines as in the chart at 8^h 45^m; but, concluding that they could not be fully trusted, I did not copy them into my MS. This evening, without being on the lookout for such appearances, I was struck with the same thing, at that time—namely, a great change in the direction of the Zodiacal Light, and I have recorded it in the chart (see 8^h 45^m). This is doubtless owing to the great change in the angle which the ecliptic makes with the horizon, as the night advances.



No. 64.

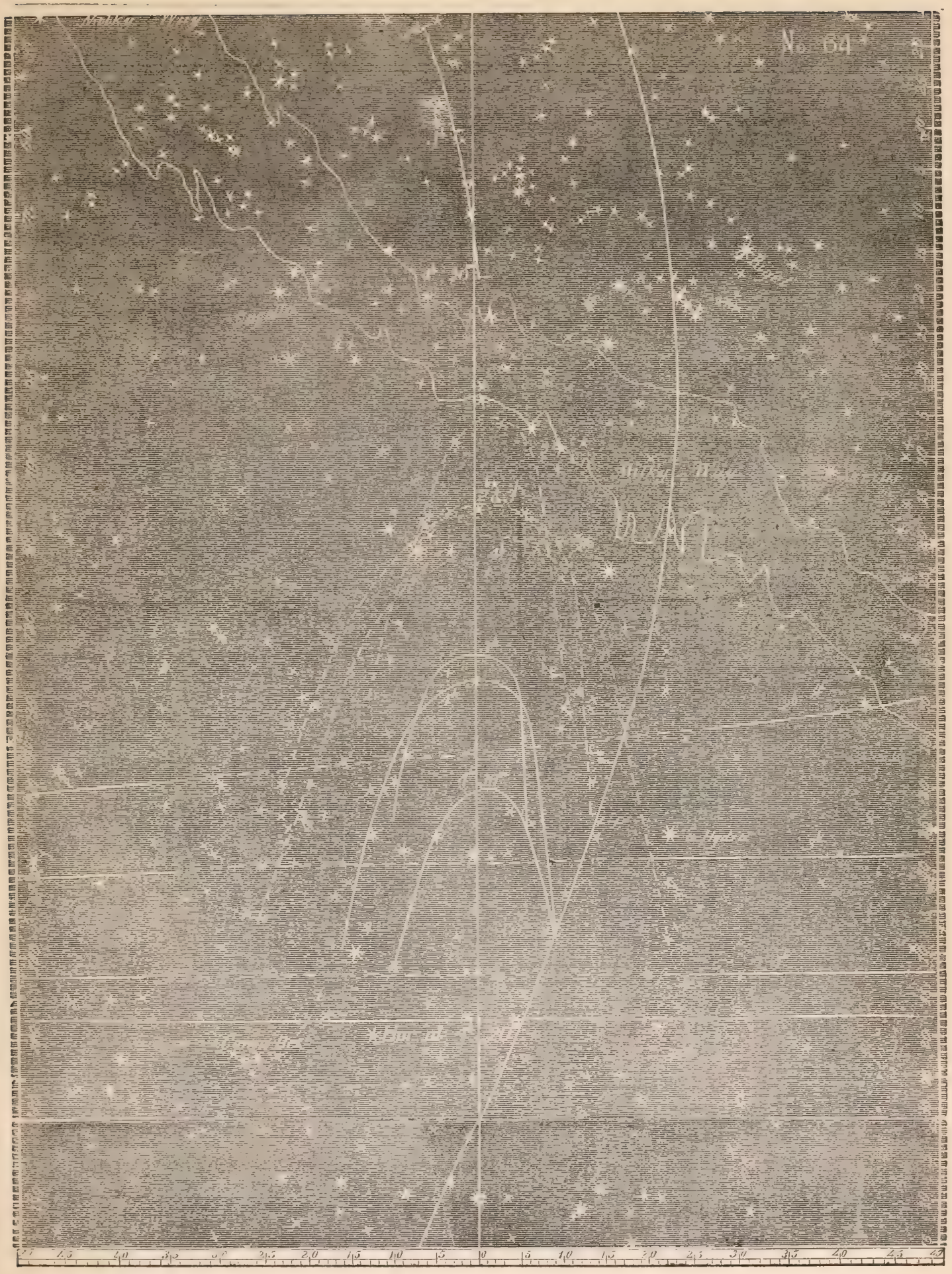
OCTOBER 3d, 1853 : MORNING.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun rose $5^h.\ 55\frac{1}{2}^m.$

Stronger Light at		Diffuse at	
$3^h.$	$0^m.$	$2^h.$	$0^m.$
4	0	3	0
4	30	4	0

Went on deck at 2 a. m., and found the Zodiacal Light, though not bright, still quite decided. Lieutenant M—— then the watch officer, was also able to make it out. In the neighborhood of Præsepe, its brightness was then equal to that of the Milky Way between Sirius and 26 of Monoceros. At 3 o'clock, the Diffuse Light at 16 Cancri was equal to the same. At 4^h, the Stronger Light was very brilliant, its outline as in the chart; but immediately after this, it began to sink rapidly, and at $4^h\ 30^m$, it had got down to the limits given also in the chart. I was not looking for this sudden change, but it was in accordance with observations on previous occasions. This Light, after it had sunk down, was also much dimmer than at 4^h; at $4^h\ 37^m$, there was a sudden and rapid spread of light beyond the Zodiacal Light bounds, and dawn had come.


No. 64

No. 65.

OCTOBER 3d, 1853: Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

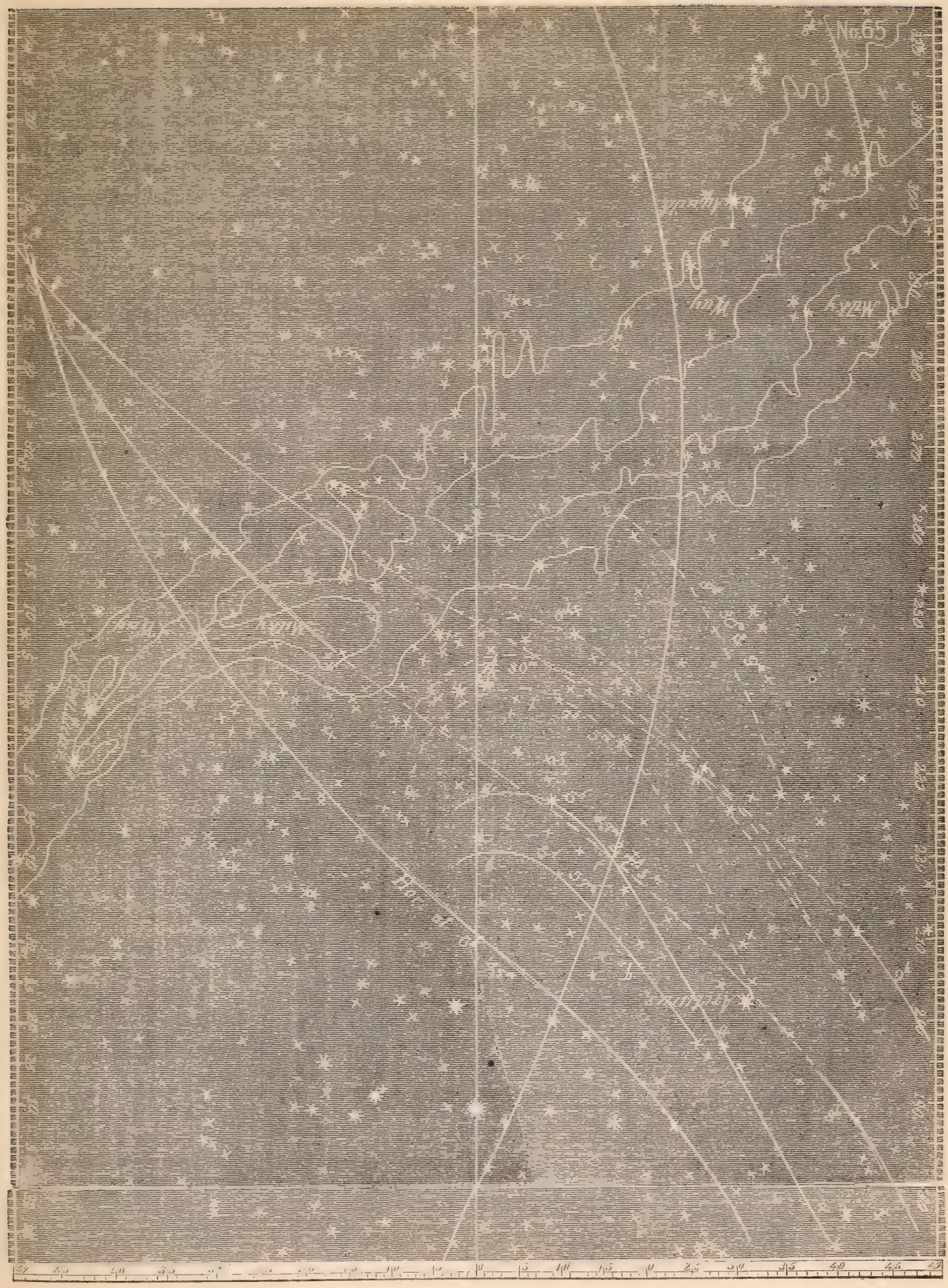
Sun set 5*h*. 42½*m*.

Stronger Light at 6*h*. 45*m*.		Diffuse at 7*h*. 5*m*.	
6	57	7	30
7	5	8	0
		8	30
		9	0

Had a fine sky for Zodiacal Light, and watched it attentively. Twilight left behind it a dull, rosy light, which gradually grew dimmer, and then died away. At 6ʰ 42ᵐ, there was almost a sudden flush of soft white, which was the Zodiacal Light; at 6ʰ 45ᵐ, it was as in the chart, the whole of it being the Stronger Light, with a little of the Diffuse Light travelling ahead at its front or upper end, the latter at 6ʰ 50ᵐ being at 38 Libræ. The Light was strongest between 99 and 109 Virginis. Now commenced a singular sight. This sudden flush at 6ʰ 54ᵐ, or thereabout (for I could not tell exactly), began rapidly to grow dim, and to contract its limits; and at 6ʰ 57ᵐ, it had receded to the boundaries given for that time in the chart, and had only half of its former intensity. Then, in a few minutes, it began to widen again (though with only the lesser intensity of 6ʰ 57ᵐ), and also to have a Diffuse Light along its borders. At 7ʰ 5ᵐ the Stronger Light had reached its former bounds as at 6ʰ 45ᵐ; the Diffuse being as given in the chart.

I noticed the same thing also on Saturday evening, but did not record it. It was so singular, that I thought it might be an ocular deception; but it showed itself decidedly on Sunday evening, just as described to-night.

At 9ʰ, the Light was very faint. I knew it had extended itself as in the chart, because, in the early part of the evening, the space about 27, 41, and 30 Ophiuchi was quite dark, and now it was brightened up continuously with the space to 1 and 2 Ophiuchi.


No. 65

No. 66.

OCTOBER 4th, 1853: MORNING.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

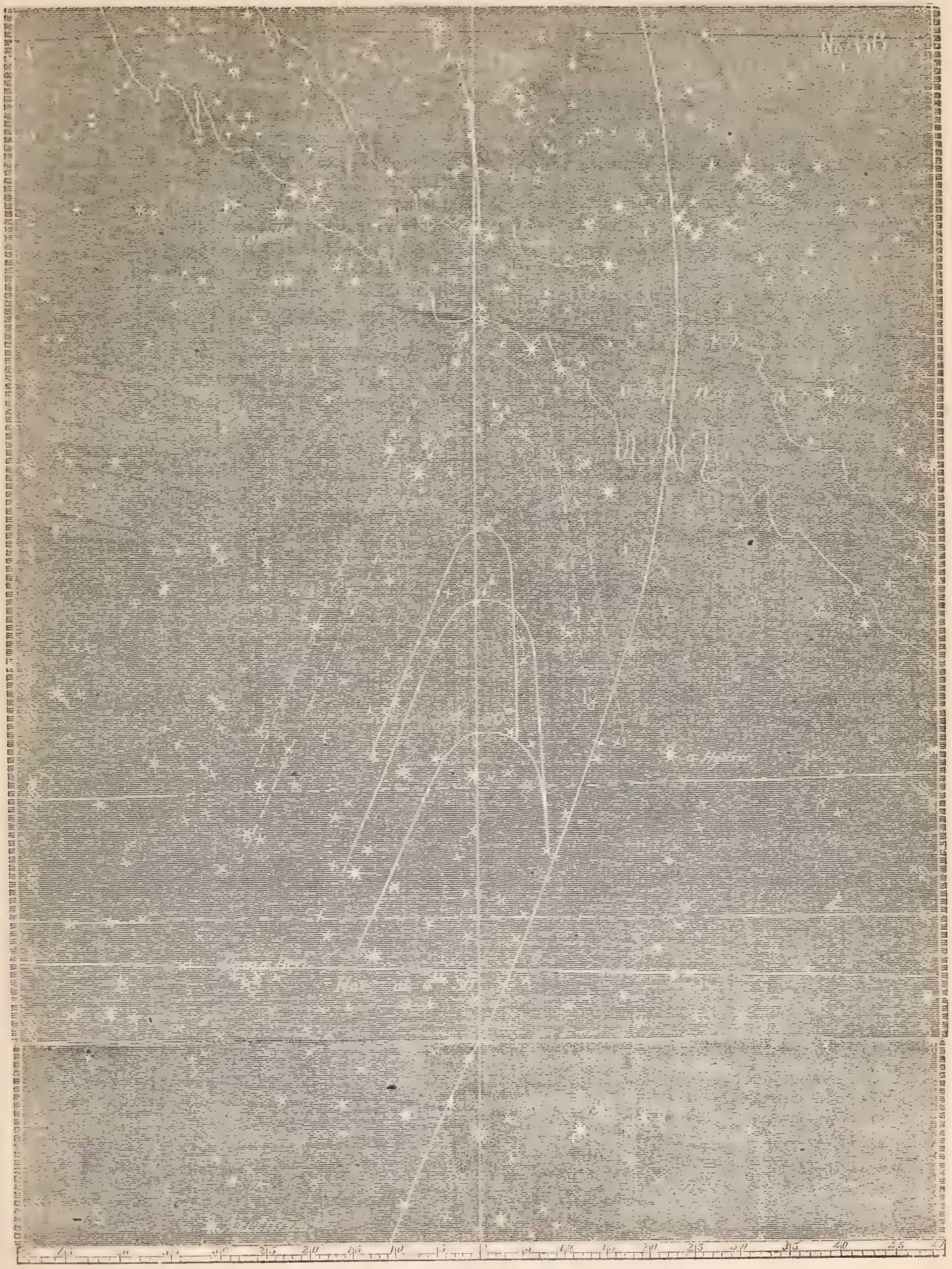
Sun rose 5*h*. 56*m*.

Stronger Light at 3*h*. 0*m*. Diffuse at 3*h*. and 4*h*.

4 0

4 30

A good morning for observations. At 4^h 26^m, the Stronger Light sunk down, and diminished in intensity. At 4^h 30^m, it was as in the chart. Then it grew once more in strength. At 4^h 37^m dawn arrived.



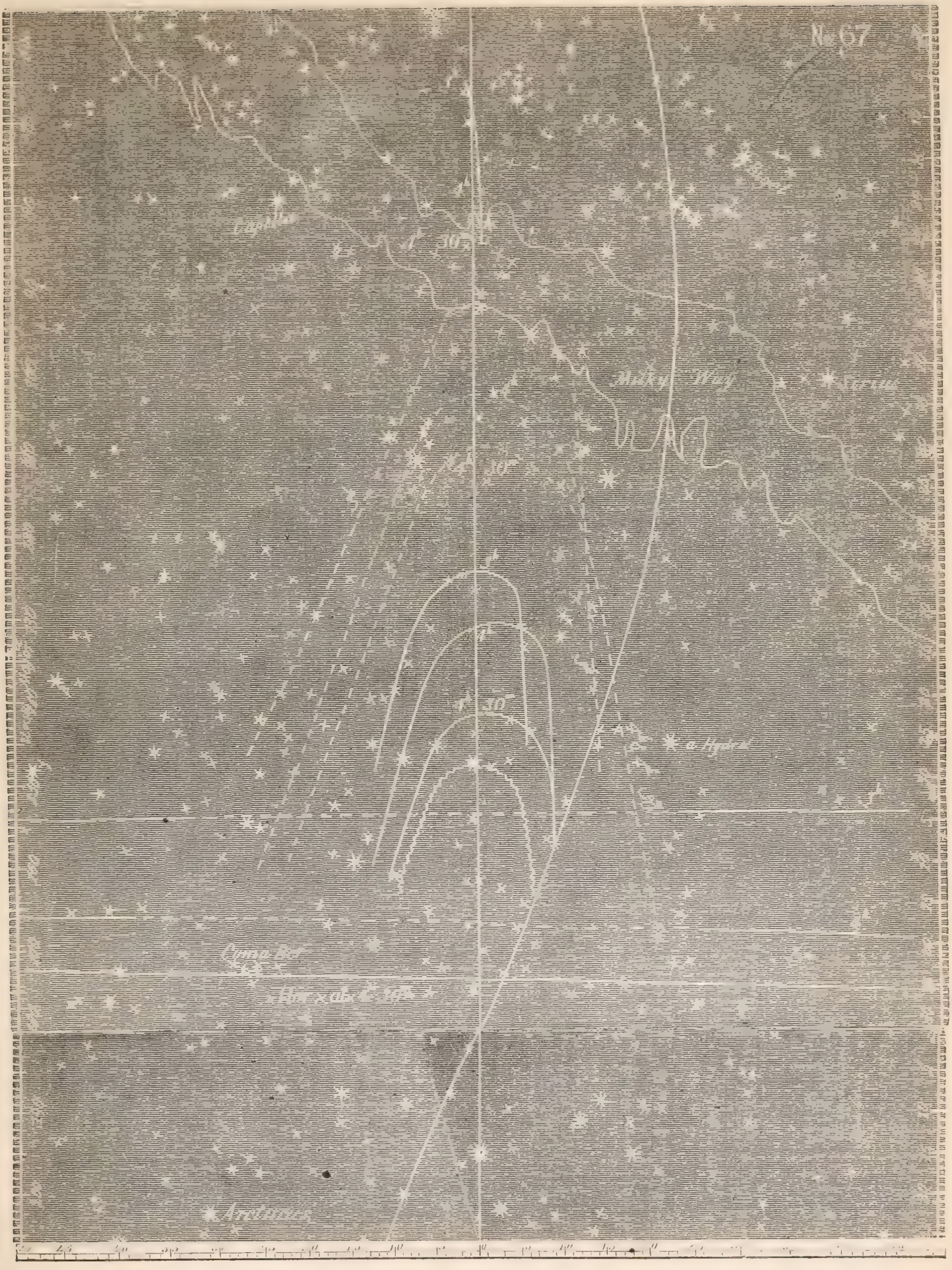
No. 67

OCTOBER 8th, 1853 : Morning

Lat. 22° 11′ N. : Lon. 113° 36′ E.
Sun rose 5*h*. 57½*m*.

Stronger Light at		Diffuse	
3*h*.	0*m*.	3*h*.	0*m*.
4	0	4	0
4	30 &c.	4	30

Clouds since the morning of the 4th. This morning the sky was remarkably clear, and I had good observations. The Milky Way prevented my ascertaining exactly the upper limits of the Diffuse Light at 3 o'clock. Was struck, this morning, with the difference between the Zodiacal Light and that of the Milky Way. The former is a soft, warm light, a little tinged with yellow, as if the sun were just going to rise; this was the appearance of the Stronger Light at 3 o'clock. This brighter part was unusually brilliant this morning. I could see nothing in the Milky Way to compare with it in brilliancy. This was particularly the case from 4^h to $4^h\ 30^m$; the zigzag line bounds a portion more effulgent than the rest. The suddenness of the change from the Zodiacal, to dawn light, is worthy of remark. This morning, I turned my eyes from the Zodiacal Light, in order to make some annotations, and when, after writing but twelve words, I looked again, the light had spread, and dawn had come. This was at $4^h\ 34^m$.

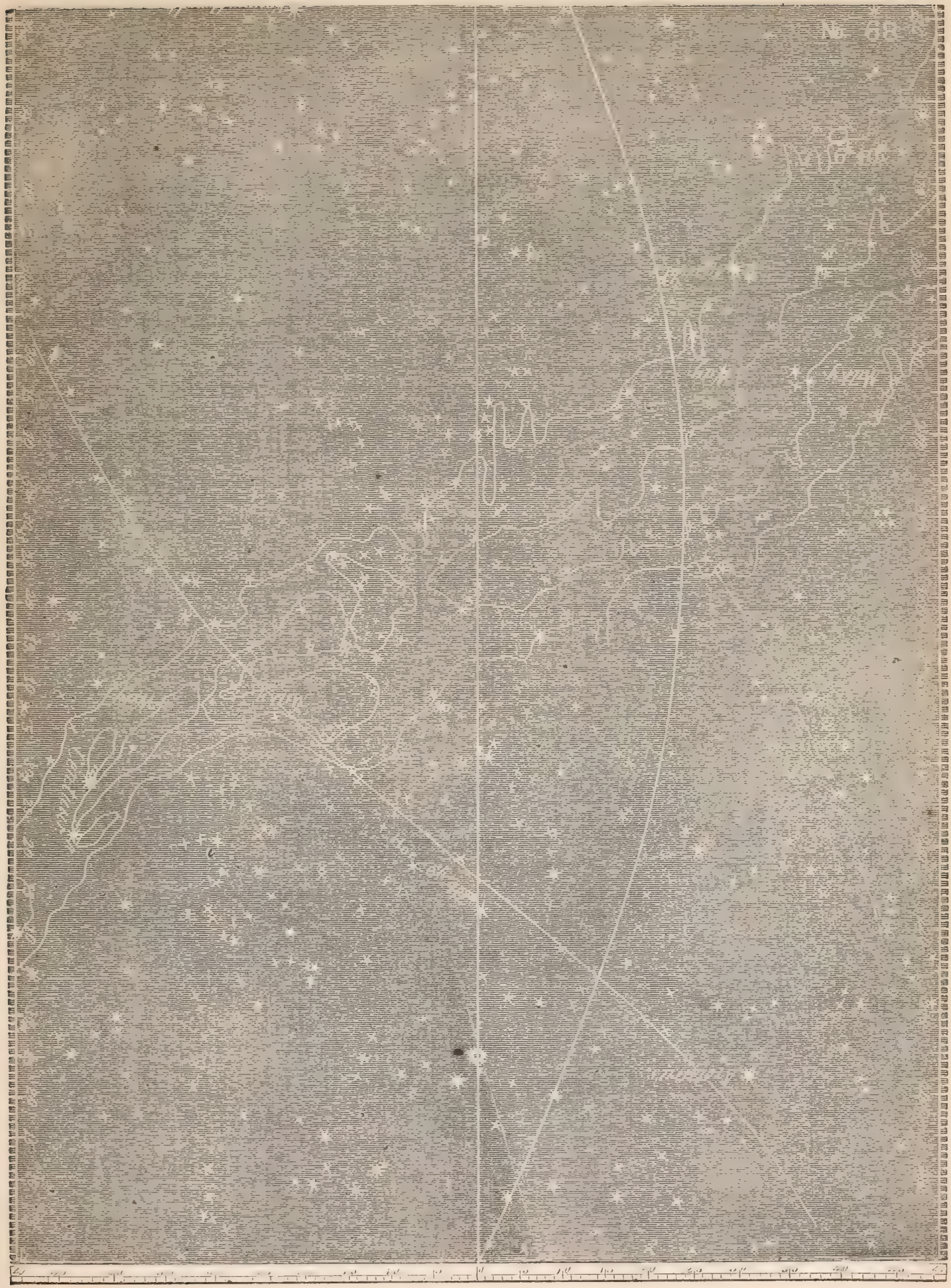

No 57
Milky Way
Aquila
Hydra
Corvus
Crater
Hercules
Ophiuchus
Scorpio
Libra
Virgo
Serpens
Bootes
Corona
Ursa Major
Leo
Coma Berenices
Canes Venatici
Draco
Cygnus
Lyra
Vulpecula
Sagitta
Aquarius
Capricornus
Sagittarius
Ophiuchus
Scorpio
Libra
Virgo
Serpens
Bootes
Corona
Ursa Major
Leo
Coma Berenices
Canes Venatici
Draco
Cygnus
Lyra
Vulpecula
Sagitta
Aquarius
Capricornus
Sagittarius

No. 68.

OCTOBER 18th, 1853: EVENING.

Lat. 22° 11′ N.: Lon. 113° 36′ E.
Sun set 5*h*. 29*m*.
Diffuse Light at 6*h*. 40*m*.

Clouds uniformly since my last entry (8th instant), except the evening of the 15th, when the moon interfered. This evening had a clear western sky. Watched to see if I could discern when the twilight changed into the Zodiacal Light. Could not tell. The position of the ecliptic is, however, unfavorable for this. The western sky, after sunset, continued red for a considerable time; this redness at last contracted its dimensions, first vertically, then horizontally; gradually the red grew dim, and changed by imperceptible degrees to a white light, the white expanding. At $6^h\ 30^m$, I *knew* I was looking at the Zodiacal Light; but it was impossible to say exactly when it had become so. The moon, after $6^h\ 40^m$, prevented further observations.

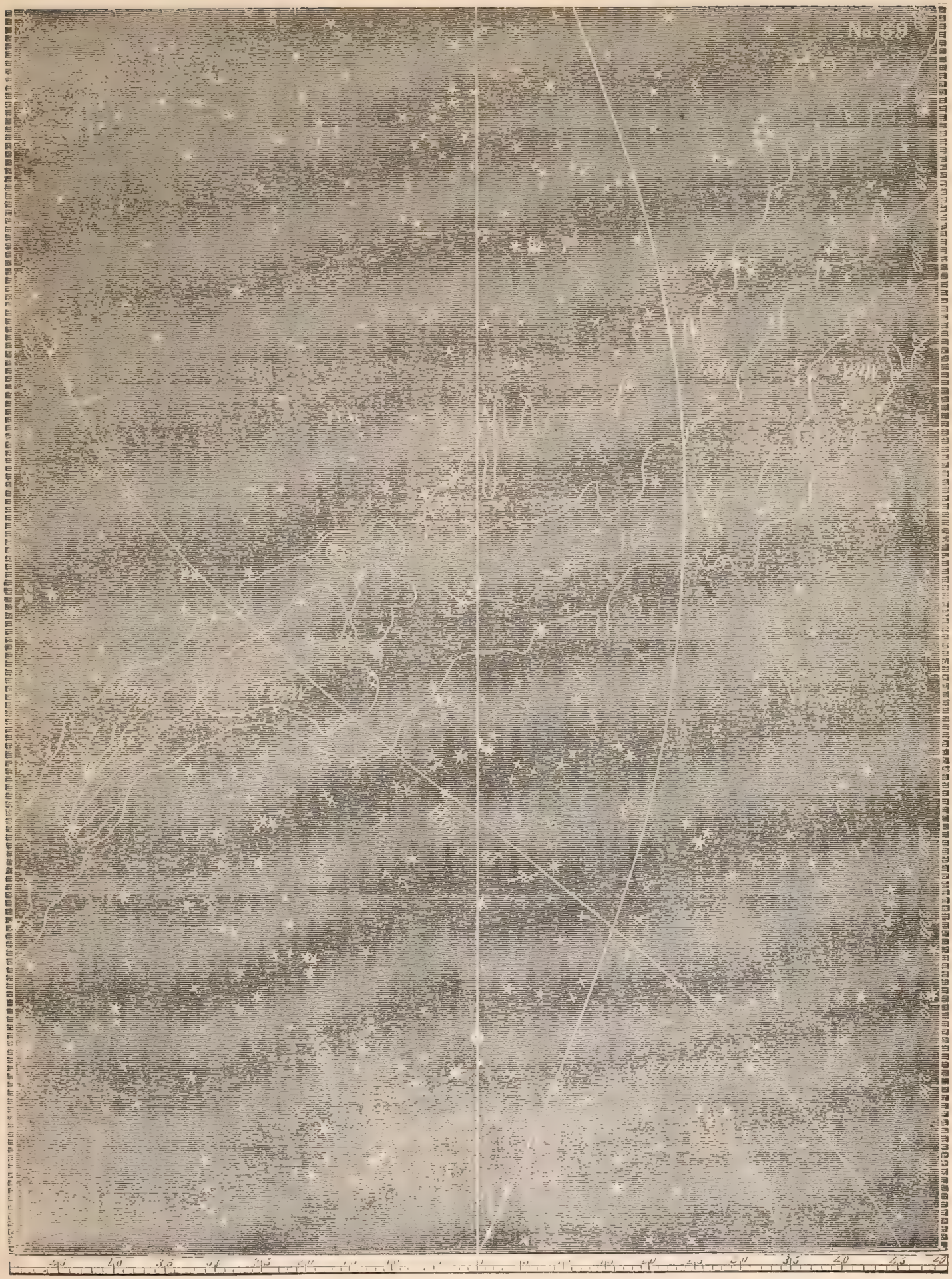


No. 69.

OCTOBER 19th, 1853: EVENING.

Lat. 22° 11′ N.: Lon. 113° 36′ E.
Sun set $5h.\ 28\frac{1}{2}m.$
Diffuse Light at $7h.$

Evening pretty favorable for Zodiacal Light. Some cirri prevented my getting the Stronger part. Was gratified in being able to get the Diffuse beyond the Milky Way. These evening observations are still particularly interesting, as the sun still strikes laterally; and consequently they help us to ascertain the breadth of the Zodiacal Light northwardly. Watched to see when I could first make it out to be the Zodiacal Light: it was so first, decidedly, at $6^h\ 30^m$. Moon rose at $7^h\ 15^m$. In the chart the boundary is double, at its lower end, on the left. My eye sometimes fixed on one, sometimes on the other, as the true boundary. I could not decide which of the two lines to adopt.

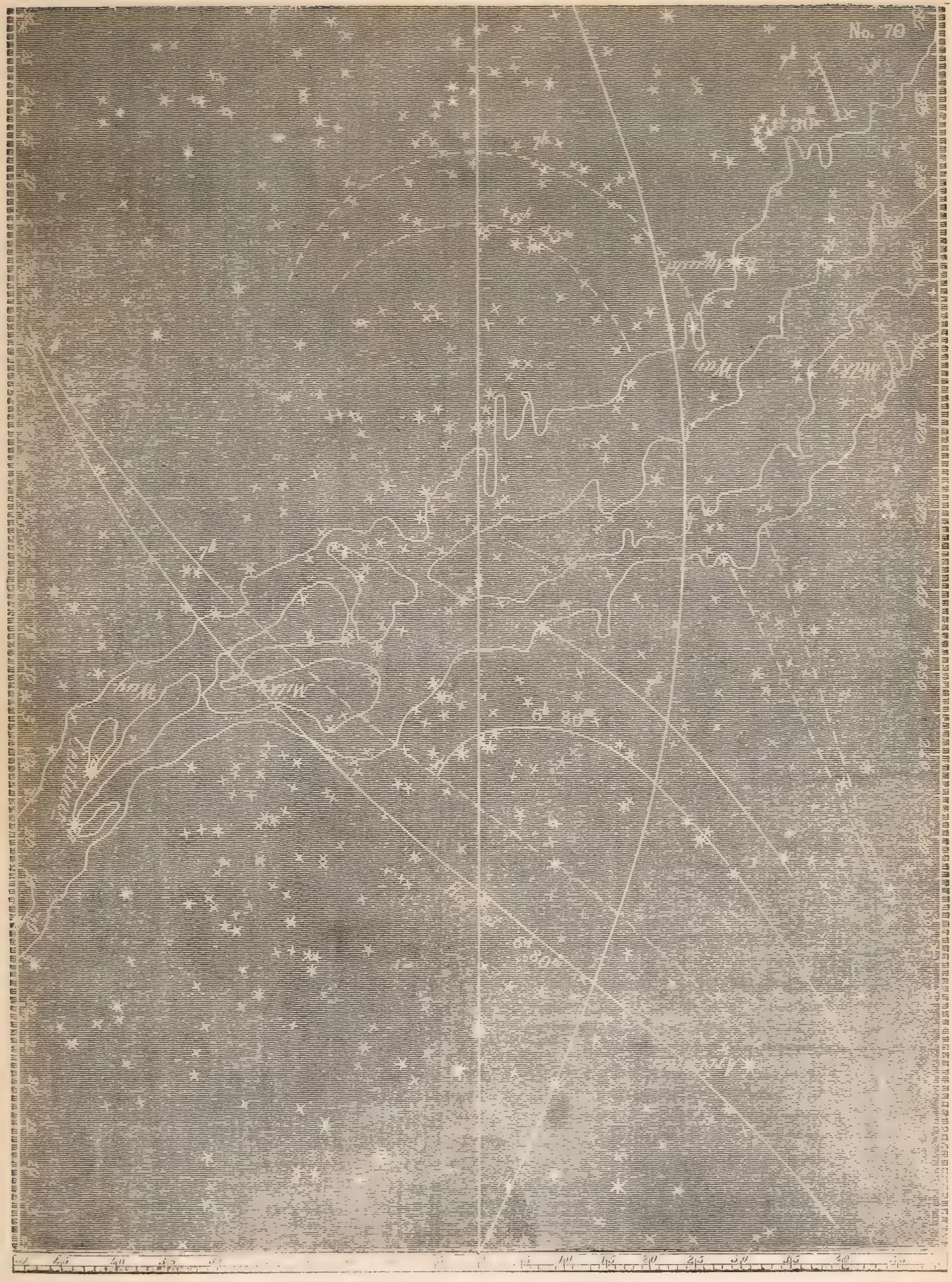


No. 70.

OCTOBER 20th, 1853 : Evening.

Lat. 22° 11′ N.: Lon. 113° 36′ E.
Sun set 5*h*. 28*m*.
Stronger Light at 6*h*. 30*m*. Diffuse 6*h*. 45*m*.
7 0 7 0

Fine evening for observations. Watched carefully to trace the first indications of the Zodiacal Light. The twilight contracted and faded; and then (I could not tell exactly the time), there was a changing into the Zodiacal Light. I *knew* it to be the latter, for the first time, at $6^h\ 30^m$; but as yet this was only the Stronger Light, the bounds as given in the chart. Then this Stronger Light began to widen, and the Diffuse Light to edge it, and to ascend pretty rapidly; and, at $6^h\ 45^m$, they were as in the chart.


No. 70

No. 71.

OCTOBER 21st, 1853 : Evening.

Lat. 22° 11′ N.: Lon 113° 36′ E.

Sun set 5*h*. 27*m*.

Stronger Light at 6*h*. 30*m*.	Diffuse at 6*h*. 45*m*.
6 45	7 0
	7 30

Fine clear evening. At $6^h\,30^m$, got the Stronger Light: but the limits of the Diffuse were not reliable. At $6^h\,45^m$, got both. At 7^h, Stronger Light with outlines as at $6^h\,45^m$, but much dimmed. At $7^h\,30^m$, this light scarcely, if at all, distinguishable from the Diffuse; the latter, itself, faint. At 8^h, its lower boundaries—*i. e.* from Corona Borealis to α Ophiuchi, alone reliable, but very faint.

No. 72.

OCTOBER 22d, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun set 5*h*. 26*m*.

Stronger Light at 6*h*. 30*m*.		Diffuse at 6*h*. 30*m*.	
6	45	6	45
7	0	7	0
		8	30

Atmosphere remarkably clear. Got the Diffuse Light at $6^h\ 30^m$. About $6^h\ 52^m$, the Stronger Light began to fade, and also to spread upward a little. At $7^h\ 7^m$, could not distinguish it from the Diffuse Light. At $7^h\ 30^m$, no Stronger Light; but the Diffuse Light very bright and distinct. Seemed to be more so than an hour before (the ecliptic now making a larger angle with the horizon); its limits appeared to be the same as at 7^h. At 8^h, it was still very bright. At $8^h\ 30^m$, quite distinct. I now turned towards the east, to look for the moon's illumination.

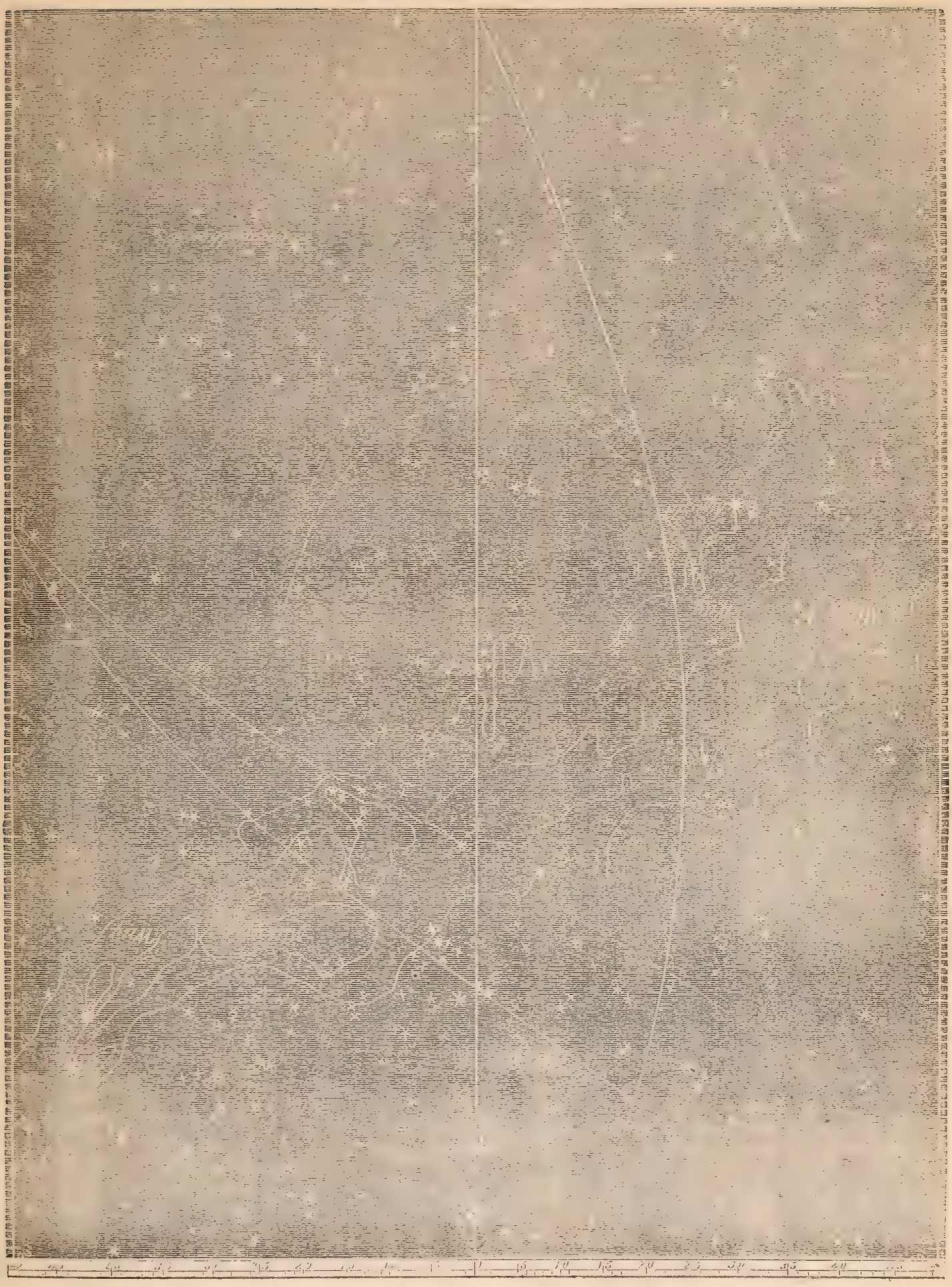
Milky Way
Milky Way
Milky Way

No. 73.

OCTOBER 27th, 1853 : Evening.

Lat. 22° 23′ N.: Lon 113° 32′ E.
Sun set 5ʰ 22ᵐ.
Diffuse Light at 7 and 8 o'clock.

Clouds from last entry (22d) until this evening. Towards 7 o'clock, the sky cleared; and, at 7ʰ and 8ʰ, had good observations; some haze and clouds along the horizon; in consequence of which, could not get the outlines of the Stronger Light.

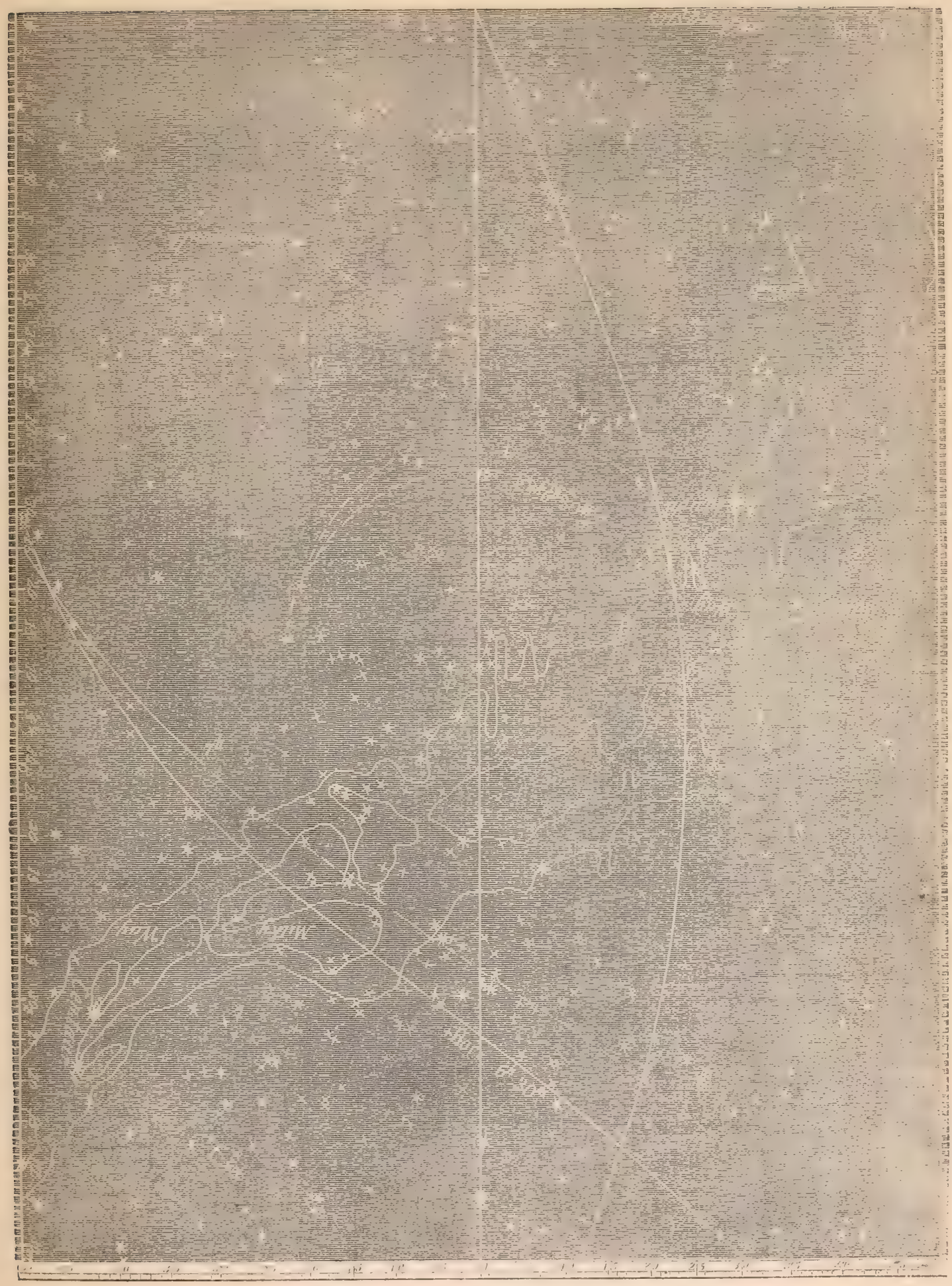


No. 74.

OCTOBER 28th, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.
Sun set 5*h*. 22*m*.
Diffuse Light at 6*h*. 30*m*. and 7*h*.

Early part of the evening pretty good. Clouds prevented my getting the outlines of the Stronger Light; and, spreading afterwards, stopped all observations at 7 o'clock.



No. 75.

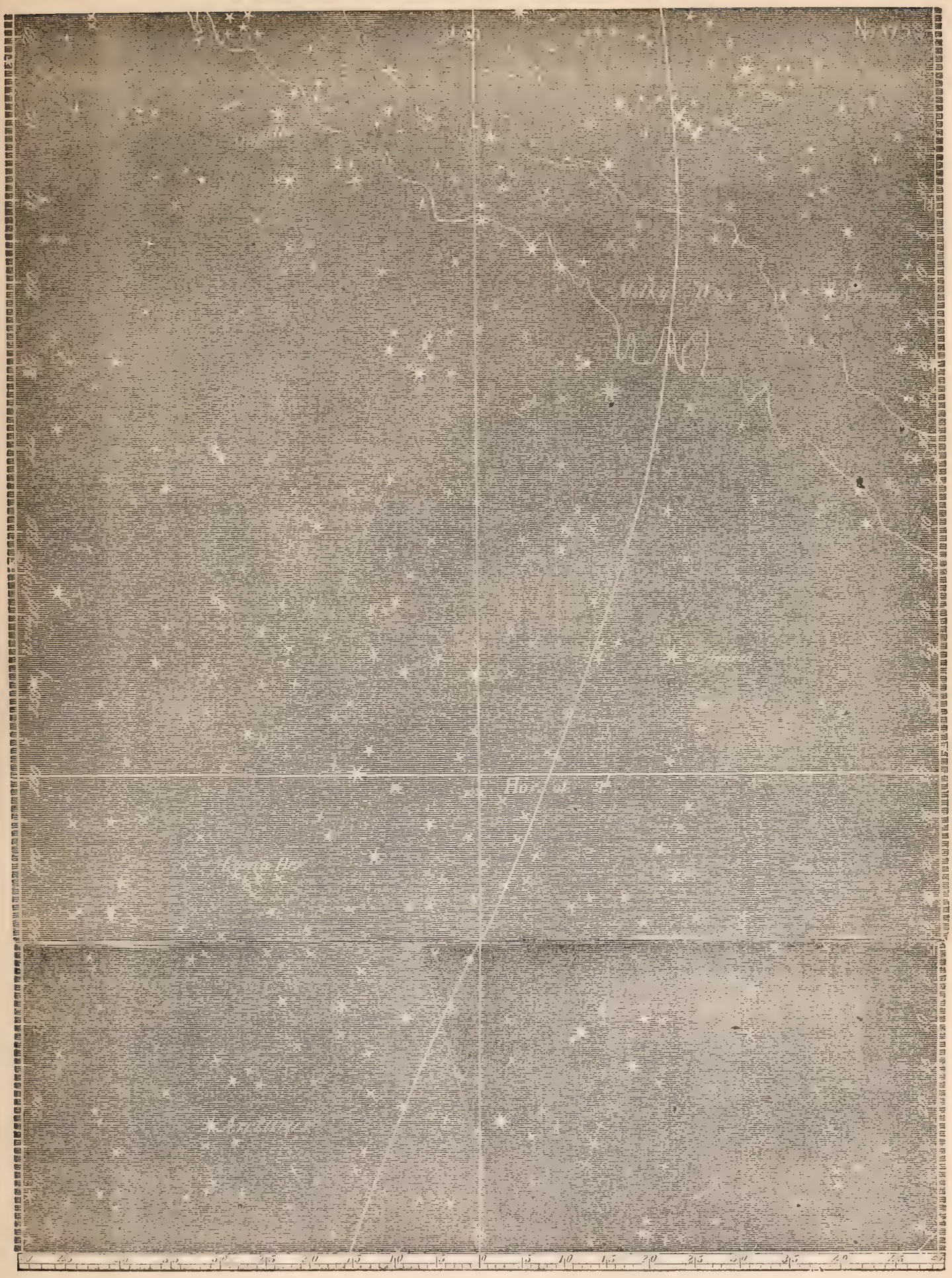
OCTOBER 29th, 1853: MORNING.

Lat. 22° 23′ N.: Long. 113° 32′ E.

Sun rose 6ʰ 6ᵐ·0

Diffuse Light at 2 o'clock.

Rose at fifteen minutes before 2ʰ, and found the sky pretty good for observations. At 1ʰ 50ᵐ, there seemed to be a faint blush of light from Præsepe down, but not enough to be taken with certainty. At 2ʰ, the light was decided, and as seen at the clock. At 2ʰ 10ᵐ, the S. pyramidal Light, about Regulus, was equal to that of the Milky Way between Theta and 31 Canis Majoris. Moon rose about 3ʰ



No. 76.

OCTOBER 29th, 1853: EVENING.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun set 5*h.* 21½*m.*

Stronger Light at 6*h.* 20*m.*		Diffuse 6*h.* 30*m.*	
6	30	7	0
7	0	8	45
8	41		

Early part of the evening very clear, and made very careful and minute observations as follows: Sun set, by watch, $5^h\ 22^m$; $6^h\ 13^m$, western sky one uniform, dead reddish color; $6^h\ 20^m$, sky has become whitened—first below, then the white ascending till it has the outline in the chart at that hour; $6^h\ 23^m$, this whiteness, as if the full moon were at β Libræ and going to rise; $6^h\ 25^m$, it is now decidedly the Zodiacal Light (the Stronger Light), its limits the same as at $6^h\ 20^m$; it is stronger and more decided towards Antares than at $6^h\ 20^m$: $6^h\ 27^m$, the Diffuse Light now spreading out from the other, and ascending; $6^h\ 30^m$, there has been all along from $6^h\ 20^m$, a patch of light stronger than the rest, as marked in the chart by the zigzag lines; $6^h\ 33^m$, this patch scarcely seen (perhaps in consequence of being lower toward the horizon); $6^h\ 45^m$, the Stronger Light about 13 Bootis equal to that of the Milky Way between Alberio and 39 Cygni. Now, clouds stop observations; 7 o'clock, the clouds have shifted, and allow observations on the left; the Stronger Light shows itself decidedly *above* the Milky Way; $8^h\ 45^m$, it is now pretty strong there; $9^h\ 30^m$, the Zodiacal Light seems still to show itself above the Milky Way, but it is difficult to distinguish it from the general whiteness of the horizon.

No. 77.

OCTOBER 31st, 1853: MORNING.

Lat. 22° 23′ N. Lon. 113° 32′ E.

Sun rose 6*h*. 7*m*

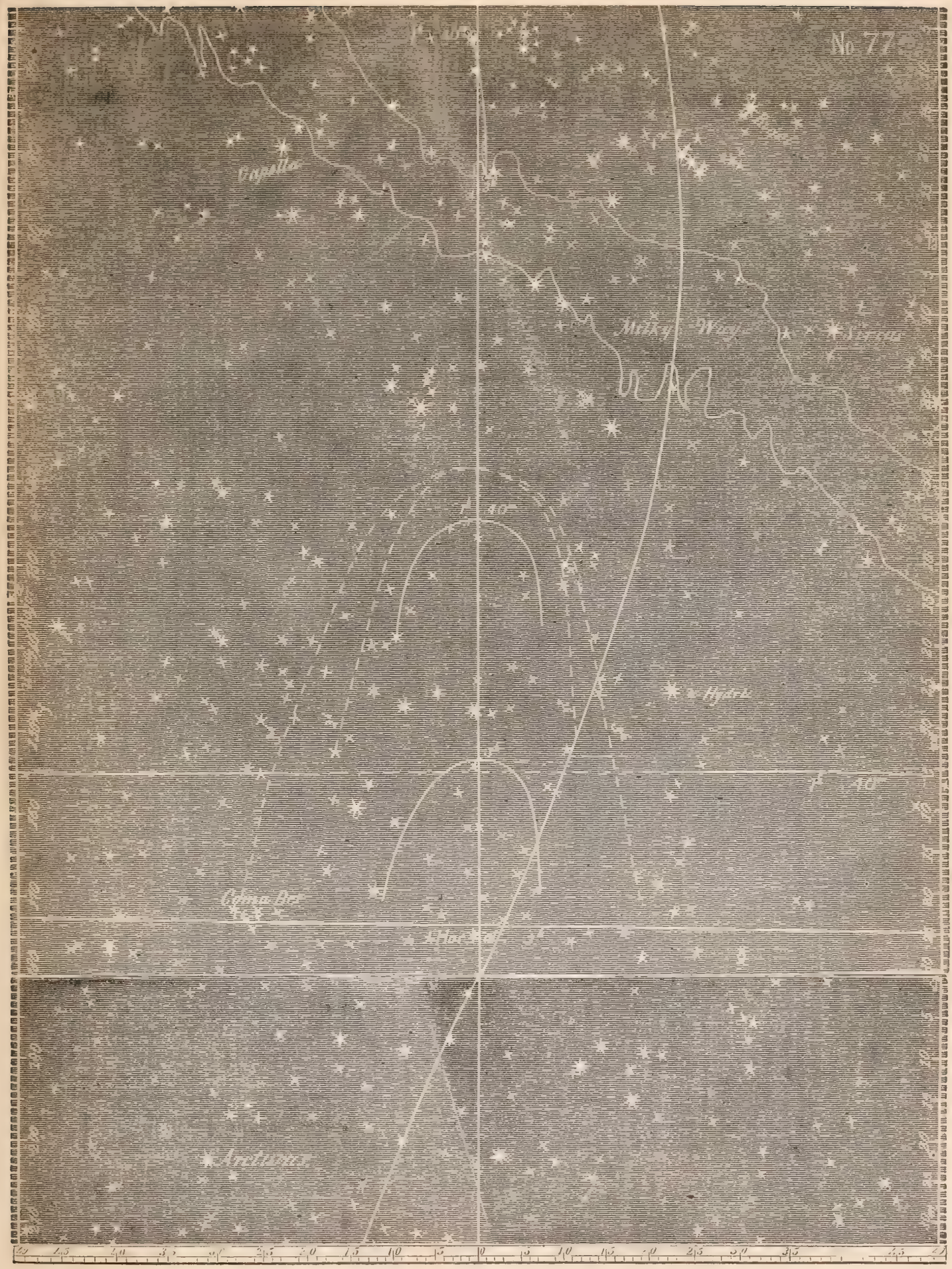
Stronger Light at 3 o'clock. Diffuse 1*h*. 40*m*.

2 0

3 0

Sun's Longitude 218°.

Was on deck at $1^h\ 40^m$, when I found a faint appearance of light within the limits marked in the chart. It was scarcely perceptible. At 2^h the Light was decidedly Zodiacal. Again on deck at 3^h, when the Stronger Light was also seen. Sky, now, clouded over; could get no further observations.


No 77
Capella
Milky Way
Vega
Hyæ
Arcturus

No. 78.

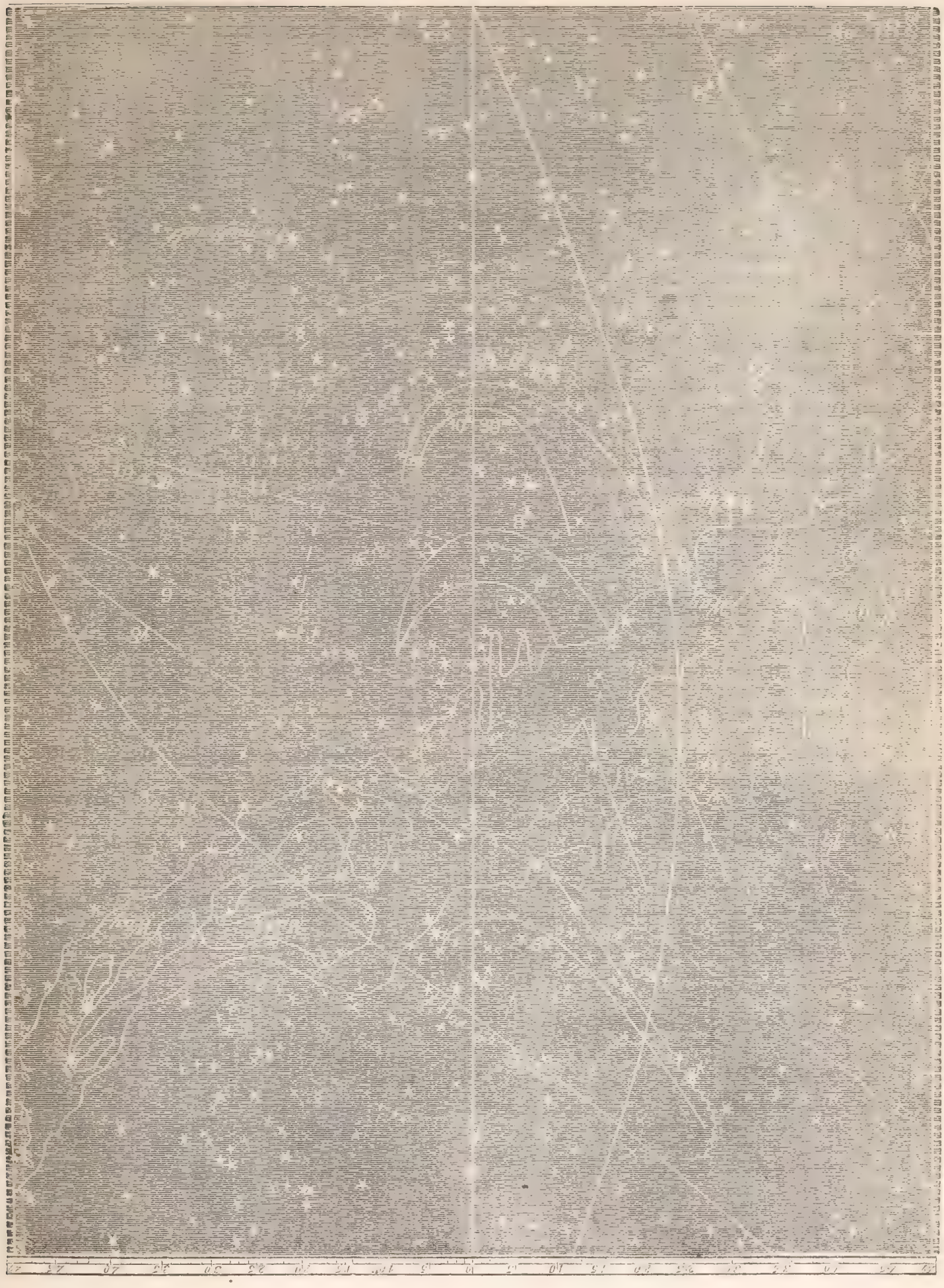
OCTOBER 31st, 1853 : EVENING.

Lat. 22° 23′ N.: Lon 113° 32′ E.

Sun set 5*h*. 20*m*.

Stronger Light at 6*h*. 27*m*.		Diffuse 6*h*. 45*m*.	
6	45	7	0
7	0	8	0
8	0	9	0
9	0		
10	30		

The atmosphere remarkably clear: made careful observation. The twilight finally left a dead reddish horizon. At $6^h\ 22^m$, this began to brighten and turn whitish, particularly under α and ε Draconis; $6^h\ 27^m$, it is now decidedly the Zodiacal Light: $6^h\ 30^m$, the Stronger Light (the only Light yet shown) has grown in strength very rapidly, and is rapidly ascending; the Diffuse Light shows itself beyond the edge of the other; $6^h\ 37^m$, there has been, from the first, a patch of light (the same as last evening, and at the same place), stronger than the rest; but this is now gone, and the Stronger Light is all equalized; for the rest, see the chart: $9^h\ 30^m$, presented the same appearance as 9^h. The atmosphere being unusually transparent (stars of the 6th magnitude very bright), I determined to watch assiduously till nothing more could be seen. At 10^h, the same as $9^h\ 30^m$; but the inclination of the ecliptic has greatly changed since 7 o'clock, and the Light (all the Stronger Light now) has shot across the Milky Way, and shows itself in great brightness beyond: $10^h\ 10^m$, there was a change: the Light began to fade rapidly; $10^h\ 30^m$, some of it left, but quite contracted in limits (see chart): 11 o'clock, *perhaps* a little left, but nothing reliable, and no boundaries can be got; nothing certain any more, and I cease observing.



No. 79.

NOVEMBER 1st, 1853 : MORNING.

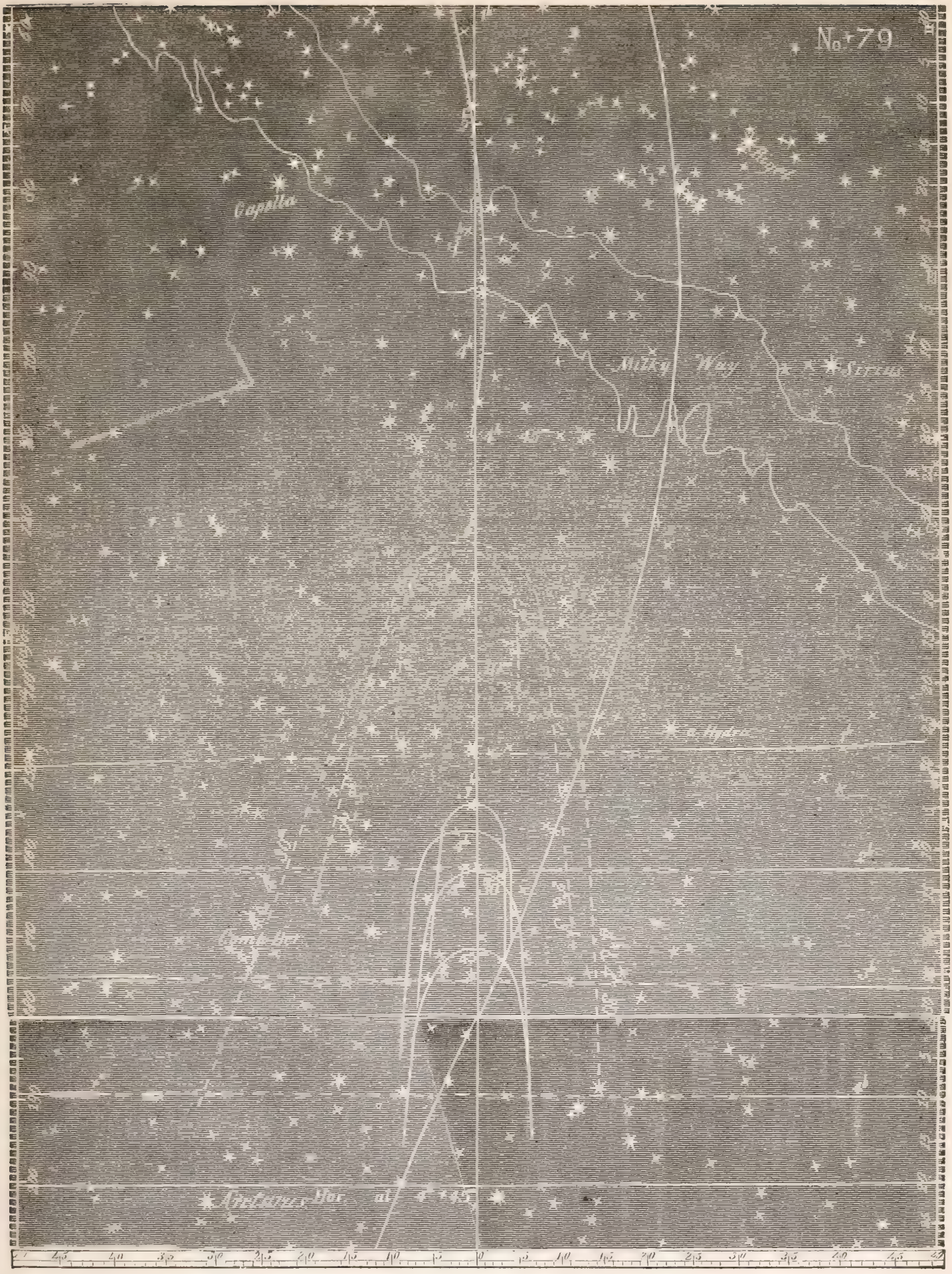
Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun rose 6*h*. 8*m*.

Stronger Light at 3*h*. 0*m*.	Diffuse at 1*h*. 0*m*.
4 0	2 0
4 30	3 0
4 48	4 0
	4 30
	4 48

Sun's longitude 219° 6′.

The atmosphere being remarkably favorable, I determined to rise so as to be able to watch for the first indications of the Zodiacal Light, in the east. Accordingly was on deck at 8 minutes before 1^h; but the Zodiacal Light was before me. There was already, from Præsepe down, a narrow strip of blush or faint Light. Distrustful of my own eyes, I got Lieutenant M—— (who had charge of the deck), to assist me with his judgment; and he agreed that there was a degree of light there, which the adjacent parts of the sky did not have. The boundaries are given in the chart. I remained on deck till 2^h, and saw this faint tinge gradually increasing in strength, and widening its borders, till it became at 2^h as in the chart. Rose again at 3^h, and found the Stronger Light showing itself. From 4^h to 4^h 30^m, the Stronger Light was really splendid. It was as if the sun were going to rise there, in a minute or two. At 4^h 30^m, it suddenly began to lose its brilliancy, and to sink down very rapidly. Its limits, at 4^h 30^m and 4^h 45^m, are given in the chart. At 4^h 50^m, the light broke bounds and spread laterally with great rapidity; at 4^h 52^m, there were no boundaries, the eastern sky had all a general whiteness, and dawn had arrived.


No. 79
Capella
Milky Way
Sirius
Procyon
Castor
Pollux
Arcturus
Mar

No. 80.

NOVEMBER 1st, 1853: Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun set 5*h*. 19*m*.

Stronger Light at 7*h*. 0*m*.		Diffuse, 7*h*. 0*m*.	
8	0	8	0
9	0	9	0
10	0	10	0
11	0		

There were clouds (cirri) in the west till 7 o'clock, when they left, and I commenced observations; the atmosphere remarkably clear quite down to the low hills which formed the horizon. Determined, as circumstances were so favorable, to watch it to the last; and also to see its first beginnings afterwards in the east, so as to know how near, in time, the eastern and western Zodiacal Lights approach each other. The evening result is in the chart. After 10 o'clock the Diffuse Light faded into nothing; at 11^h, the other had become very faint, but was still perceptible. This lasted till 11^h 30^m, when there was nothing any longer reliable; nothing certain to distinguish that part of the sky.

No. 81.

NOVEMBER 2d, 1853 : Morning.

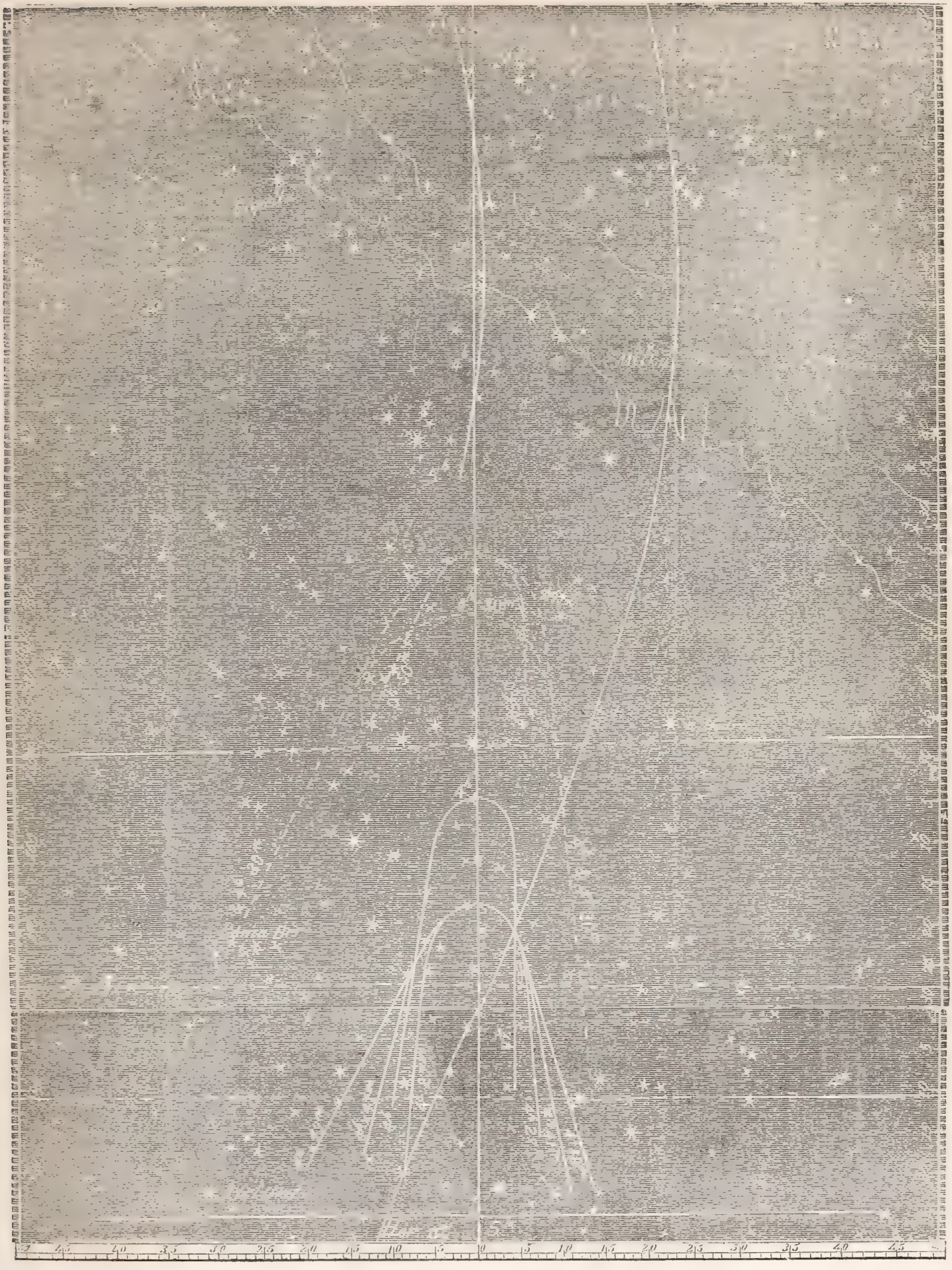
Lat. 22° 23′ N.: Lon. 113° 32′ E.
Sun rose 6*h*. 9*m*.

Stronger Light at	Diffuse
0*h*. 50*m*.	4*h*. 0*m*.
4 0	4 30
4 27	
4 41	
4 49	

Sun's longitude 220°.

Was on deck at midnight, to watch for the first indications of the Zodiacal Light. Præsepe was above the horizon, but the sky below it was like every other part: watched closely, but could see nothing till half an hour past midnight, when I thought there was possibly a little tinge of white, but was doubtful; $12^h\ 35^m$, thought the tinge had increased, but was still doubtful; $12^h\ 40^m$, the light pretty reliable as the Zodiacal Light. At $12^h\ 50^m$, I called the quartermaster on duty, and, pointing to a stretch of about 90° along the horizon, said: "Does any part of that sky appear brighter to you than the rest?" He answered immediately, pointing to the portion below Præsepe, "Yes, sir, it is considerable brighter just here." This was also my own opinion. So between the disappearance of the western, and the appearance of the eastern Zodiacal Light, in reliable forms, there was an interval of 80 minutes.

For the rest, see the chart. At $4^h\ 25^m$, the Stronger Light suddenly sunk (in two minutes' time), and at $4^h\ 27^m$, was as in the chart, being also much diminished in brightness. At $4^h\ 40^m$, it widened rapidly below; at $4^h\ 49^m$, was as in chart. At $4^h\ 50^m$, the light broke bounds effectually, and spread over the sky; at $4^h\ 52^m$, dawn had fully come.



No. 82.

NOVEMBER 3d, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun set 5^h. $18\frac{1}{2}^m$.

Stronger and Diffuse Light at 7^h. 0^m.

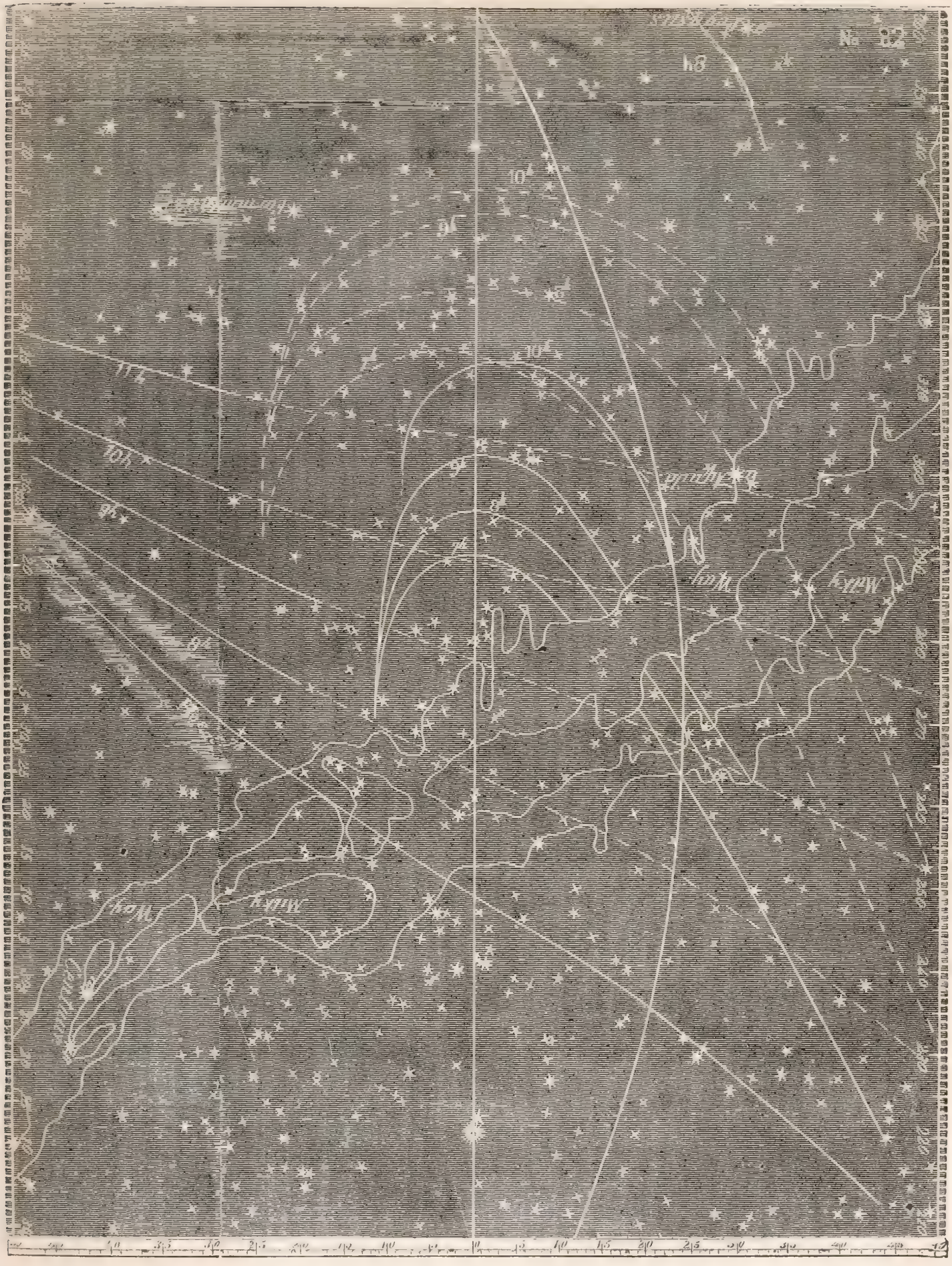
8^h 0^m

9^h 0^m

10^h 0^m

Determined again to watch the Zodiacal Light till its entire disappearance; but, a little before 11^h, the sky became clouded in patches, which prevented my getting boundaries from that time on. The light, however, could be seen between the clouds (made even more striking by them), until 11^h 45^m. The quartermaster on watch, in answer to a question from me, said, at once, that the sky was brighter there (*i. e.* about β Aquarii), than in the other parts of the sky.

The clouds lasted till dawn.


No. 82
h8
10h
9h
11h
10h
10h
9h
8h
Milky Way
Milky Way
Milky Way

No. 83.

NOVEMBER 4th, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun set 5*h*. 7½*m*.

Stronger Light at 8*h*. 20*m*.		Diffuse 8*h*. 20*m*.	
9	0	9	0
10	0	10	0
		11	0

Sun's longitude 222°.

Clouds in the morning, and moon in the evening till 8^h. Got observations then, and till 11^h, at which latter time clouds had commenced floating up, so as to cover part of the Zodiacal Light; no further reliable observations could be had. At 9^h, the Stronger Light at 56 and 57 Sagittarii, was equal to that of the Milky Way about 16 Vulpis.

No. 84.

NOVEMBER 5th, 1853 : Evening.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

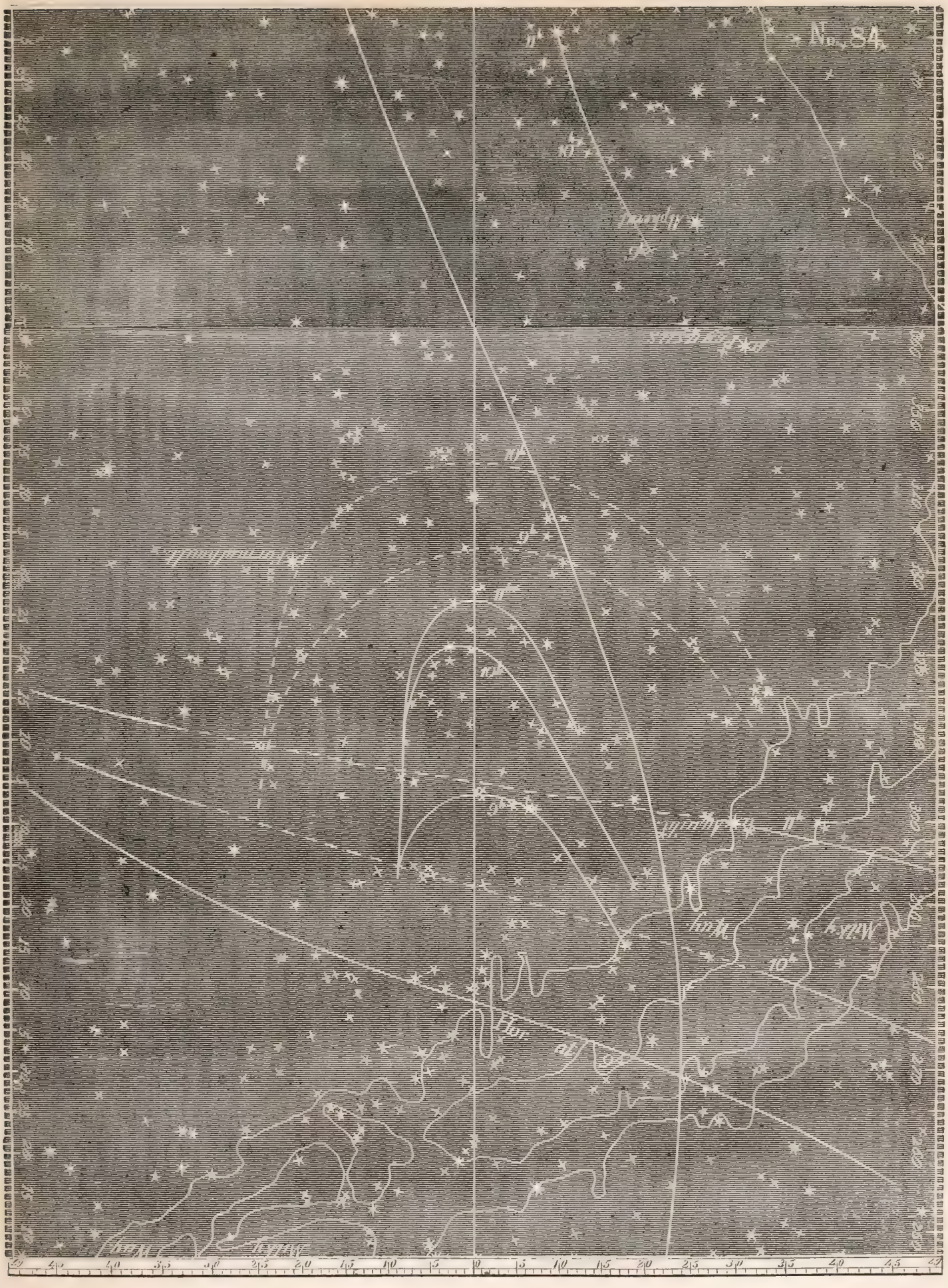
Sun set 5*h*. 17*m*.

Stronger Light at		Diffuse	
9*h*.	0*m*.	9*h*.	0*m*.
10	0	10	0
11	0		

Sun's longitude 223° 1′.

Clouds in the morning. Moon this evening set a little before 9^h; got observations from that time on. Evening clear and good for work. Worthy of notice, how, as the evening advances, and the ecliptic increases its angle, the Light shoots upward, narrowing its cone. At 12^h, the ecliptic is nearly perpendicular to the horizon.

At 11^h, the Diffuse Light seemed to have the same boundary as at 10^h, but I could not determine reliably. Thought that the Stronger Light could be made out till $11^h\ 30^m$; by which time, however, it had become so low down, and so mixed with the whiteness at the horizon, that I could now no longer speak of it with certainty. The existence of the Diffuse Light at $11^h\ 30^m$, could also not be affirmed with certainty.


No. 84.
Milky Way
Milky Way

No. 85.

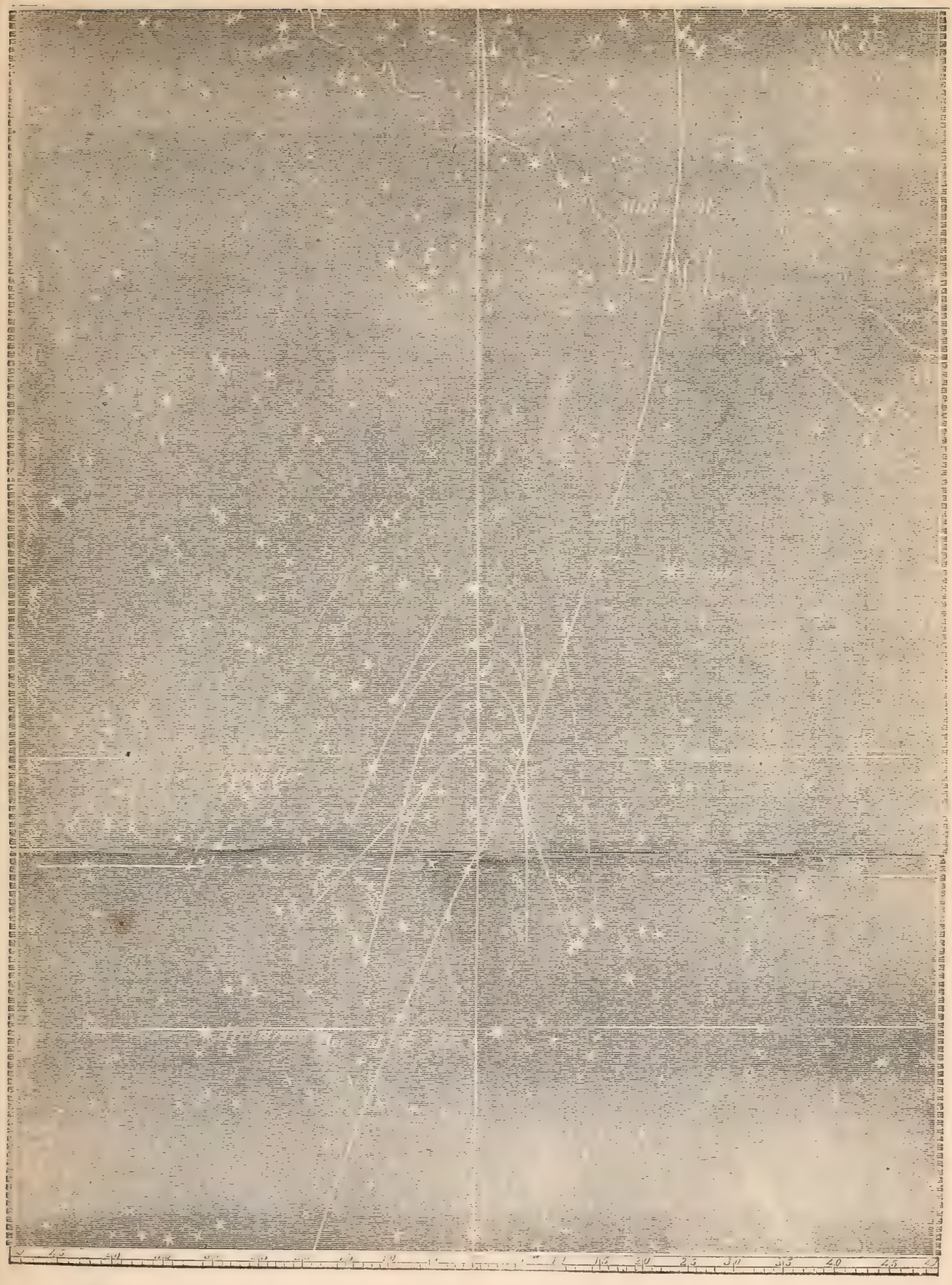
NOVEMBER 8th, 1853: Morning.

Lat. 22° 23′ N.: Lon. 113° 32′ E.

Sun rose 6*h*. 12*m*.

Stronger Light at		Diffuse	
2*h*.	15*m*.	2*h*.	0*m*.
3	0	3	0
4	0	4	0
4	20		
4	27		

Clouds since last entry (5th). Rose this morning at 2^h, and had observations thence on till twilight. Morning favorable. The Stronger Light began to be reliable at 2^h 15^m (rather suddenly). At 4^h 15^m, this Light was very strong; but at 4^h 20^m, it suddenly sunk to 77 Leonis Majoris, and at the same time was greatly dimmed. At 4^h 24^m, it began to brighten again, and to expand below; and at 4^h 27^m, its limits were as in the chart. At 4^h 50^m, it had brightened again considerably. At 4^h 56^m, it broke bounds, and at 4^h 58^m dawn had arrived.



No. 86.

NOVEMBER 22d, 1853: Evening.

Lat. 22° 11′ N.: Lon. 113° 36′ E

Sun set $5^h.\ 11\frac{1}{2}^m$.

Stronger and Diffuse Light at 7 o'clock.

Clouds constantly since last entry (8th). This evening at 7^h, had an observation; sky pretty clear. At 8^h, clouds had intervened; I got no further observations.

Aldebaran
Pleiades
Capella
Rigel
Procyon
Sirius
Betelgeux
Castor
Pollux
Regulus
Spica
Arcturus
Antares
Vega
Deneb
Altair
Fomalhaut
Markab
Pegasus
Andromeda
Cassiopeia
Perseus
Auriga
Gemini
Cancer
Leo
Virgo
Libra
Scorpio
Ophiuchus
Hercules
Corona
Bootes
Draco
Ursa Major
Ursa Minor
Cepheus
Lyra
Cygnus
Aquila
Delphinus
Equuleus
Aquarius
Capricornus
Sagittarius
Pisces
Cetus
Aries
Taurus
Eridanus
Orion
Lepus
Canis Major
Canis Minor
Hydra
Crater
Corvus
Centaurus
Lupus
Ara
Corona Australis
Piscis Australis
Grus
Phœnix
Argo
Hydrus
Toucan
Indus
Pavo
Octans
Chamæleon
Musca
Crux
Triangulum Australe
Apus
Circinus
Norma
Telescopium
Lupus
Scorpio
Sagittarius
Capricornus
Aquarius
Pisces
Cetus
Aries
Taurus
Eridanus
Orion
Lepus
Canis Major
Canis Minor
Hydra
Crater
Corvus
Centaurus
Lupus
Ara
Corona Australis
Piscis Australis
Grus
Phœnix
Argo
Hydrus
Toucan
Indus
Pavo
Octans
Chamæleon
Musca
Crux
Triangulum Australe
Apus
Circinus
Norma
Telescopium
Lupus
Scorpio
Sagittarius
Capricornus
Aquarius
Pisces
Cetus
Aries
Taurus
Eridanus
Orion
Lepus
Canis Major
Canis Minor
Hydra
Crater
Corvus
Centaurus
Lupus
Ara
Corona Australis
Piscis Australis
Grus
Phœnix
Argo
Hydrus
Toucan
Indus
Pavo
Octans
Chamæleon
Musca
Crux
Triangulum Australe
Apus
Circinus
Norma
Telescopium

No. 87.

DECEMBER 5th, 1853: Morning.

Lat. 22° 11′ N: Lon. 113° 36′ E.
Sun rose 6*h* 29*m*.
Stronger Light at 1*h* 15*m*. and 2*h*.
Sun's longitude 253° 19′.

Cloudy from 22d ultimo to this date. Rose at ten minutes before 1ʰ. At 1 o'clock there seemed to be a blush of light in the sky, from Regulus down. Should not have doubted it, if there had not been a similar kind of blush along the horizon from this place to the Milky Way, on the right. At 1ʰ 12ᵐ, took outlines, but do not feel perfectly satisfied about the character of the Light. At 1ʰ 37ᵐ, it seemed to be pretty decided. At 2ʰ, scarcely a doubt about it. There would have been none, if it had not been for this blush, still on the right; but this latter did not extend upward, like the other. At 3ʰ, the sky has all clouded over once more.

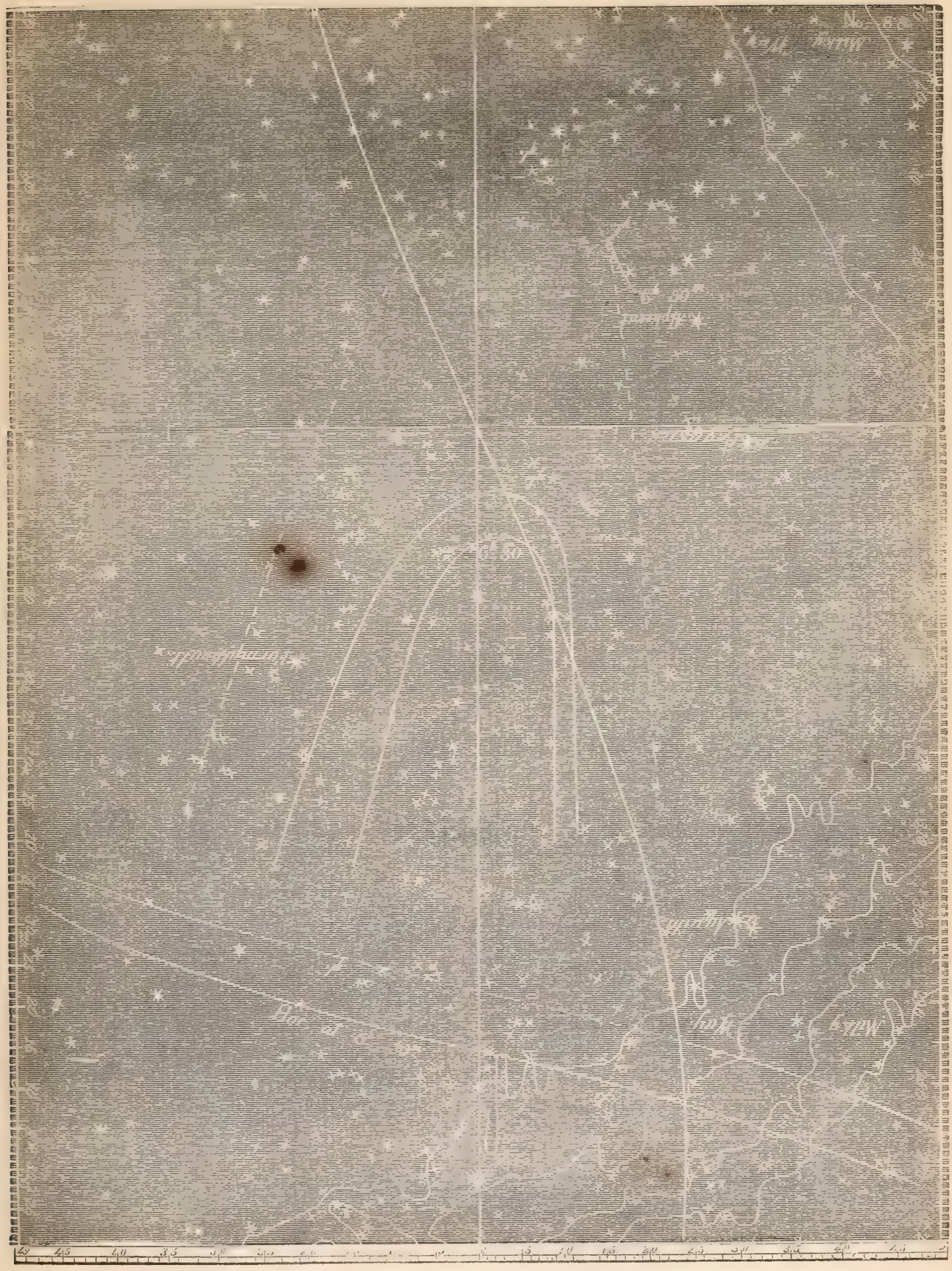
Aldebaran
Pleiades
Algol
Perseus
Auriga
Capella
Taurus
Aries
Andromeda
Pegasus
Cassiopeia
Cepheus
Ursa Major
Ursa Minor
Draco
Camelopardalus
Lynx
Gemini
Cancer
Leo
Leo Minor
Coma Berenices
Canes Venatici
Bootes
Corona Borealis
Hercules
Lyra
Cygnus
Vulpecula
Delphinus
Aquila
Sagitta
Equuleus
Pegasus
Aquarius
Capricornus
Sagittarius
Ophiuchus
Serpens
Scutum Sobieskii
Antinous
Aquila
Delphin

No. 88.

DECEMBER 21st, 1853 : Evening.

Lat. 23° 4′ N : Lon 113° 26′ E.
Sun set 5*h*. 16½*m*
Stronger Light at 6*h*. 30*m*. and 7*h*. Diffuse 7*h*.

Clouds since last date till this evening, when I succeeded in having some good observations, for which see the chart. Clouds immediately after spread over the sky, and prevented further observations.



No. 89.

DECEMBER 28th, 1853: Evening.

Lat. 22° 18′ N: Lon. 114° 10′ E.

Sunset 5*h* 22*m*.

Stronger and Diffuse Light at 7*h* 0*m*.

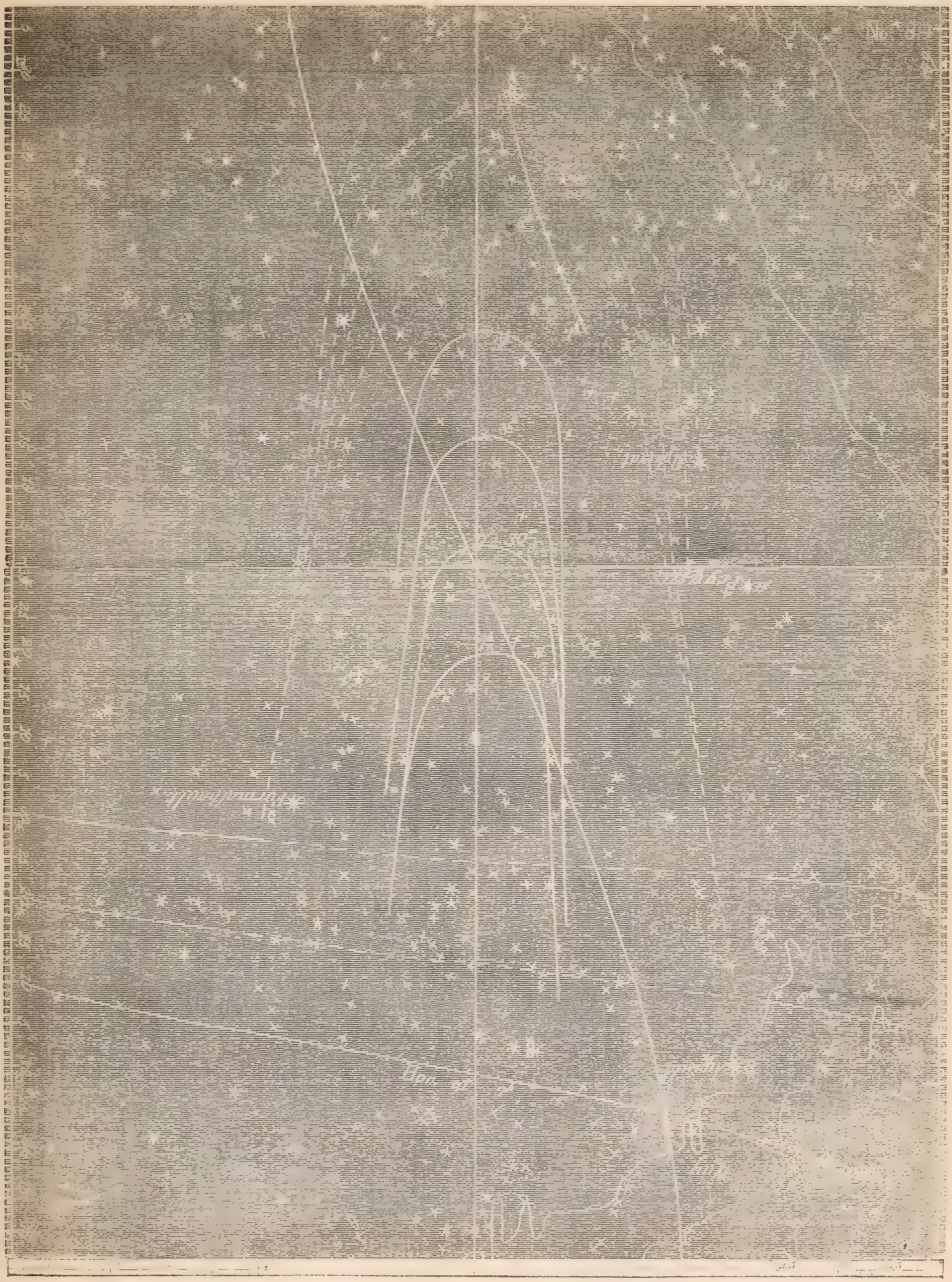
7 30

8 0

9 0

Sun's longitude 276° 11′.

Clouds uniformly since last date until to-day. This evening sky perfectly clear. The planet Venus interferes somewhat with observations, but good outlines can still be procured. At 5*h* 30*m*, the Zodiacal Light discernible, but faint; 6*h* 38*m*, stronger, but too dim to give reliable outlines. At 7*h*, got outlines of both Diffuse and Stronger Light, but the former Light was dim. For the rest, see chart. At 10*h*, the Diffuse Light still to be seen, its outlines the same as at 9*h*; no Stronger Light to be seen. At 11*h*, there seemed to be some Light left, but nothing reliable.



No. 90.

DECEMBER 29th, 1853: MORNING.

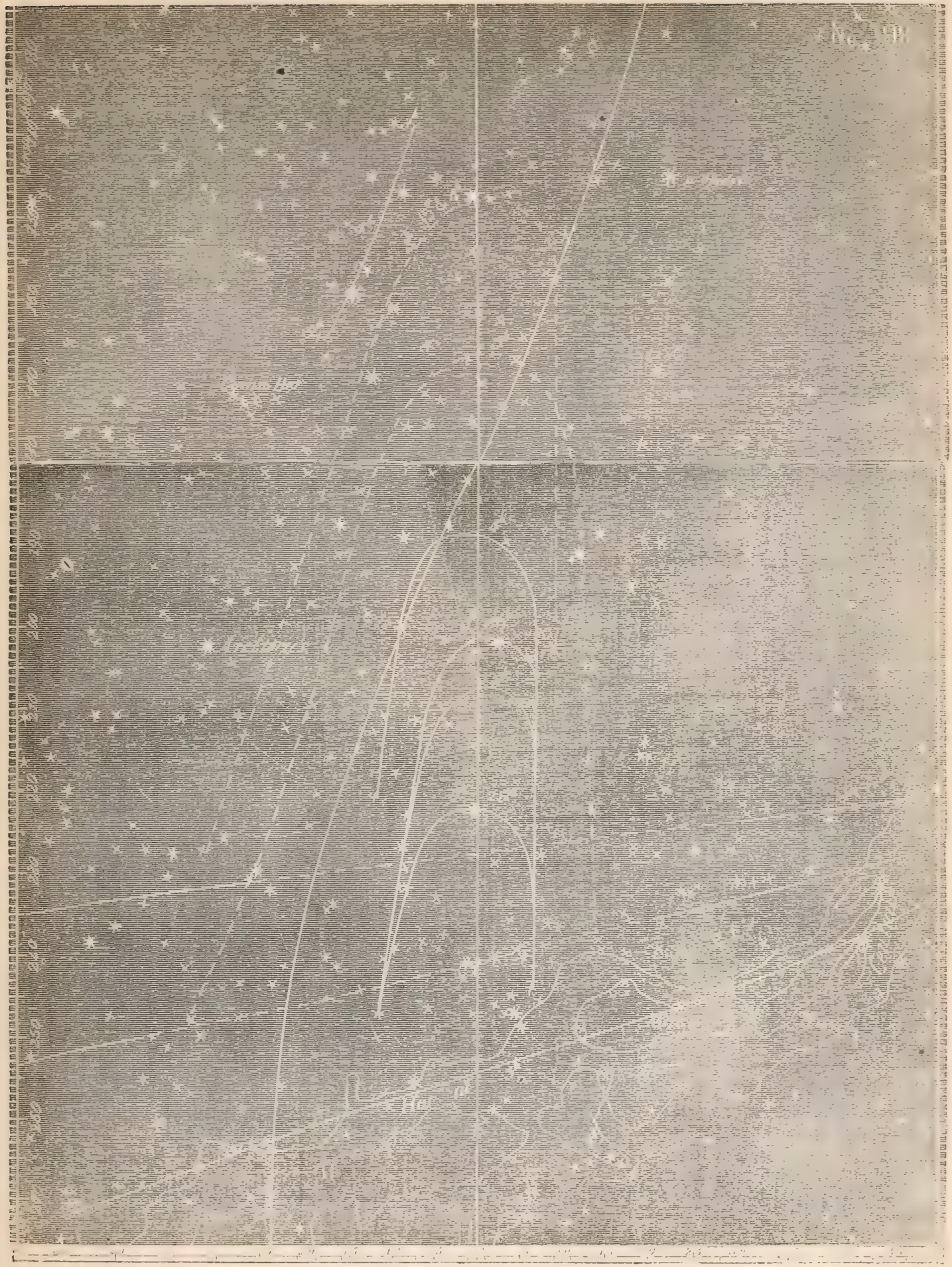
Lat. 22° 18′ N.: Lon. 111° 10′ E.

Sun rose 6*h*. 42*m*.

Stronger Light		Diffuse	
3*h*.	30*m*.	3*h*.	15*m*.
4	0	4	0
5	0	5	0
5	25		

Sun's longitude 279° 45′.

Rose a little before 3^h. Atmosphere remarkably clear, and morning very fine. Observations as in the chart. At 5^h 25^m, the Stronger Light sunk suddenly down from the limits marked for 5^h, to those marked 5^h 25^m, in the chart. At 5^h 31^m, it broke bounds and spread, and dawn had come.



No. 91.

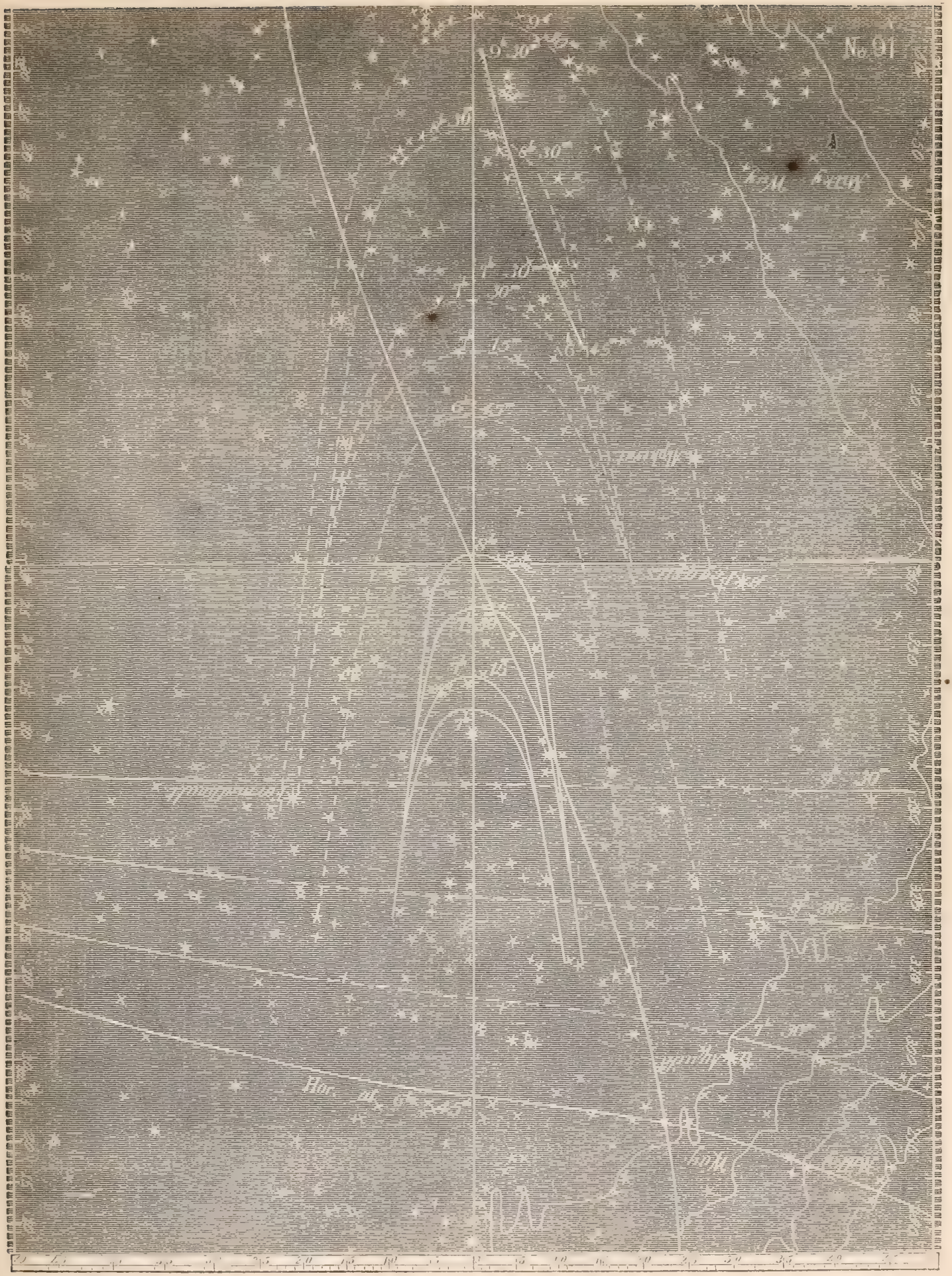
DECEMBER 29th, 1853 : Evening.

Lat. 22° 18′ N.: Lon. 114° 10′ E.

Sun set 5*h*. 23*m*.

Stronger Light at 7*h*. 0*m*.		Diffuse 6*h*. 45*m*.	
7	15	7	15
7	30	7	30
8	30	8	30
		9	30

Atmosphere remarkably clear. Sky unclouded. Watched to see how the Zodiacal Light would first show itself. It came so gradually that nothing belonging to it could be made out, till at $6^h\ 30^m$, it was evident that the sky along its place had paled somewhat. The twilight is long, and at $6^h\ 35^m$ darkness had not fairly set in. But the Zodiacal Light was faintly marked in the sky, even before the stars were all fully out. The Light was not strong enough to give boundaries till $6^h\ 45^m$, when I got those of the Diffuse Light; the Stronger did not show itself distinct from the other till $6^h\ 55^m$; at 7^h, I got its boundaries. For the rest, see the chart. The Light was brightest at about $7^h\ 30^m$. The Stronger had dimmed at $8^h\ 30^m$, but was yet good. At $9^h\ 30^m$, there was no Stronger Light *as such;* but the Diffuse was very bright, the Stronger seeming to have spread into this. Exhausted by last night's watching, I now went to bed.


No. 91

No. 92.

DECEMBER 30th, 1853: Morning.

Lat 22° 18′ N.: Lon. 114° 10′ E.

Sun rose 6*h*. 43*m*.

Stronger Light		Diffuse	
3*h*.	0*m*.	3*h*.	0*m*
3	30	3	30
4	30	4	30
5	20 Paled sky	4	30
5	25		

Sun's longitude 278° 47′.

Morning sky fine and clear. Intended to be up at $1^h\ 50^m$, but was not waked till near 3^h. Took boundaries as in the chart. At 3^h, the Stronger Light was faint, the Diffuse very distinct. This last, at all this morning's observations, seemed to run up to Præsepe, coming nearly to a point there: but I could not be certain about it, and have put ? to the doubtful lines. The Zodiacal Light was strongest at about $4^h\ 30^m$. At this hour ($4^h\ 30^m$), I was surprised to find that the Diffuse Light on the left, or north, had greatly extended its boundaries, running through the middle of Corona Borealis. I have, for that hour, given, with the Stronger and the Diffuse Light, also this latter extension, marked by dots and *aaa*, though it was so strong as to be very little different from the Diffuse Light itself. I was not looking for this; but I now remember a similar sudden extension, northwardly, in the evening Light of the 1st of July. This is in the same part of the sky, and is probably owing to the same cause—namely, that the approach of the ecliptic to the horizon brings this nebulous substance more laterally to the eye. There is now, between midnight and 5 o'clock, a great lessening of the angle of the ecliptic with the horizon, particularly towards 4 or 5 o'clock. This extended light is, however, much stronger than that of July, when first seen; being, in this respect, the opposite of that. This extended light seems to reach up to Præsepe; but as the space between Regulus and Præsepe is quite void of stars above those of the 6th magnitude, I am doubtful of it. Still, there does seem to be a positive whiteness, as of the Zodiacal Light. From $5^h\ 20^m$ to $5^h\ 25^m$, the Stronger Light sunk rapidly down, and was very much dimmed. At $5^h\ 32^m$, the Light broke bounds and spread, and dawn had come. This spreading, however, is not so striking as it was in September and October.

No. 92.
Milky Way

No. 93.

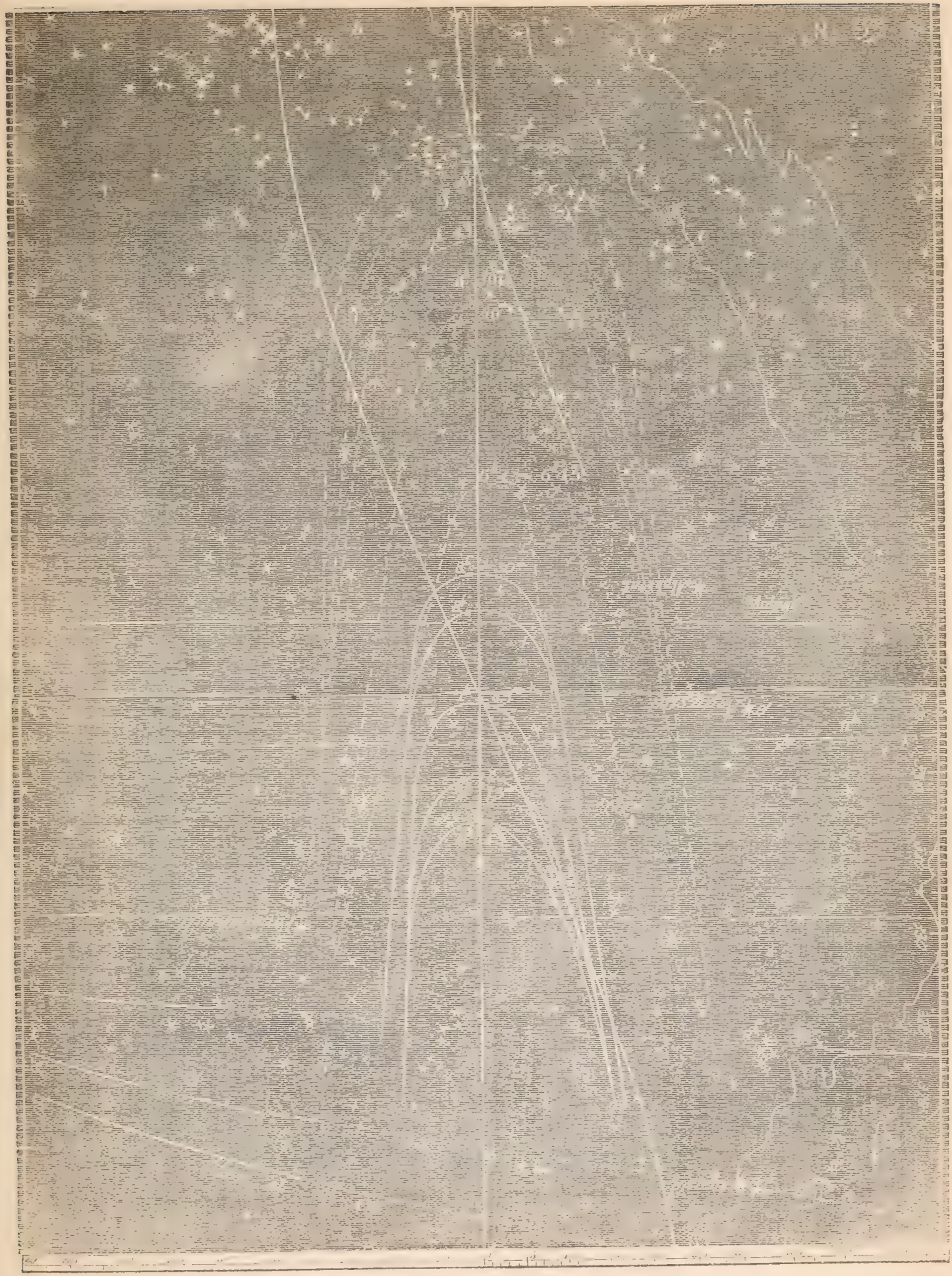
DECEMBER 30th, 1853. Evening.

Lat. 22° 18′ N. Lon. 114° 10′ E.

Sun set 5h 24m

Stronger Light at	6h 45m	Diffuse	6h 45m
7	15	7	20
7	45	7	45
8	0	8	30
8	30	9	30
		11	30
		Midnight	
		12	30
		1	0

A most favorable time. Atmosphere perfectly clear, and sky good down to the horizon. Victoria mountain (Hong Kong) interferes a little, but not so as to produce any difficulty. I determined to watch this night through, in order to see all the changes of the Zodiacal Light, and to discover how long it would last in the west, and how soon it would appear in the eastern sky. The ecliptic, at this time, is most favorable for the endurance of the Light, being nearly vertical to the horizon at midnight, so as to give as little trouble as possible from haziness or the ordinary glare along the horizon. I was well rewarded to-night, having had the rare satisfaction of seeing the Zodiacal Light at once, at the east and west, at 12 o'clock. The following are my notes: "At 6h 30m, twilight not quite past, and the stars imperfectly out; but the Milky Way is clearly distinguishable, and so also is the Zodiacal Light, though the latter is dim. I tried to get its boundaries; but after succeeding in one or two spots, had to give it up, the Light being so faint as not to give reliable outlines throughout. At 6h 42m, succeeded; 6h 45m, could get outlines of Stronger Light. Observations from this on, as in the chart. The Stronger Light was strongest at 7h 45m; by 8h 30m it had become dim. At 9h 30m Stronger Light almost gone; it has ascended, and widened into the Diffuse, which is now very distinct and bright—brightest at its lower end. At 11h, quite distinct, as high as the Pleiades, its limits narrower than before, and running up cone-shaped: brightest at lower end. It perhaps extended up as far as 123 Tauri (tip of the horn), but I was not certain; it rather seemed so to me. At 11h 30m, Light still visible, but dim. Thought, then, it *did* extend up to 123 Tauri. Boundaries as at 11h. It was now simply a paling of the sky. At midnight, still a paling of the sky; boundaries as at 11h; it is, however, scarcely perceptible. Now saw the Zodiacal Light also in the *east*, for which see morning chart of December 31st, and remarks. At 12h 30m, the western Light still seemed to continue; its boundaries as before. It was as bright as the extreme edge of the Milky Way, just by Gomeisa, but has a warmer tint than the Milky Way. At 1h, it still seemed to be visible—appeared *not to be going out*, but to be sinking with the Pleiades; its limits as before. At 2h, it had quite gone."



No. 94.

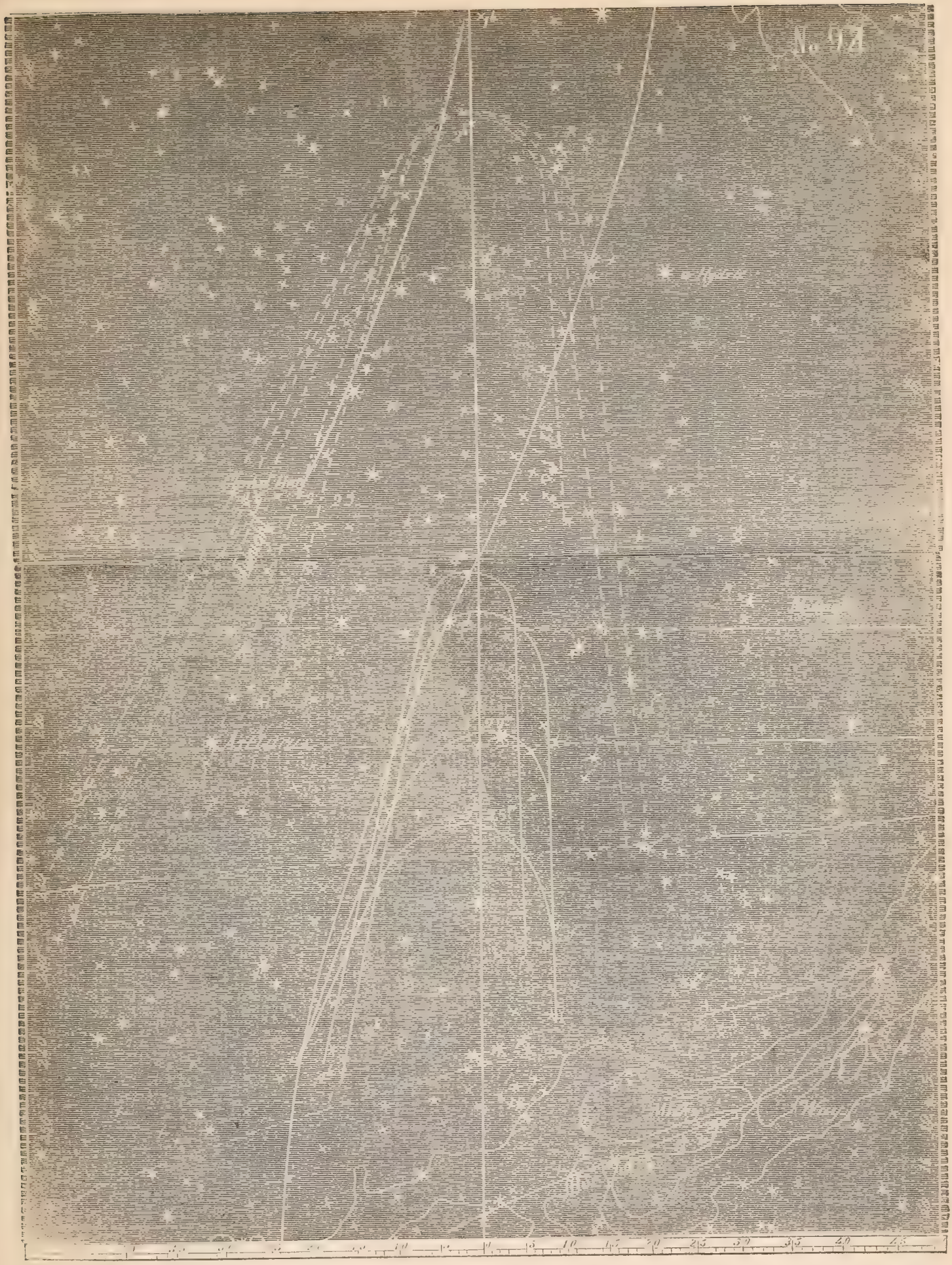
DECEMBER 31st, 1853 : MORNING.

Lat. 22° 18′ N.: Lon. 114° 10′ E.

Sun rose 6*h.* 42*m.*

Stronger Light 4*h.* 0*m.*	Diffuse at Midnight.
5 0	0*h.* 30*m.*
5 22	1 0
5 25	2 0
	4 0
	5 0

At 12^{h} (midnight) turned from the west, where the Zodiacal Light was still visible, and found it showing itself also in the east. Distrustful of my own eyes, I called the quartermaster on watch, and, directing him "to draw a line by two certain stars" (Regulus to Mars), said: "Tell me whether the sky looks paler to you along that line, and a little on either side? Look for some time." He soon replied: "Yes, sir, it looks paler and dim." I said: "How far up?" He replied: "To that bright star" (Regulus); but thought it might be to the dim cluster above (Præsepe)." Which latter was also the limit, as it appeared to me. At 30 minutes past midnight, seemed to be a little brighter; same limits as before. At 1 o'clock the Light was quite distinct; not simply a paling of the sky, but a positive light. At 2^{h} 30^{m}, Light increased—quite strong from 29 Virginis down. Soon after 5^{h}, the Stronger Light began to descend rapidly, as the chart will show, till it rested as marked at 5^{h} 25^{m}; at 5^{h} 32^{m}, broke bounds, and dawn had come.


No. 92

No. 95.

JANUARY 2d, 1854: MORNING.

Lat. 22° 18′ N.: Lon. 114° 10′ E

Sun rose 6*h*. 43*m*.

Stronger Light 2*h*. 0*m*.		Diffuse 0*h*. 30*m*.	
3	0	1	0
4	0	2	0
5	0	3	0
5	10	4	0
5	25	5	0

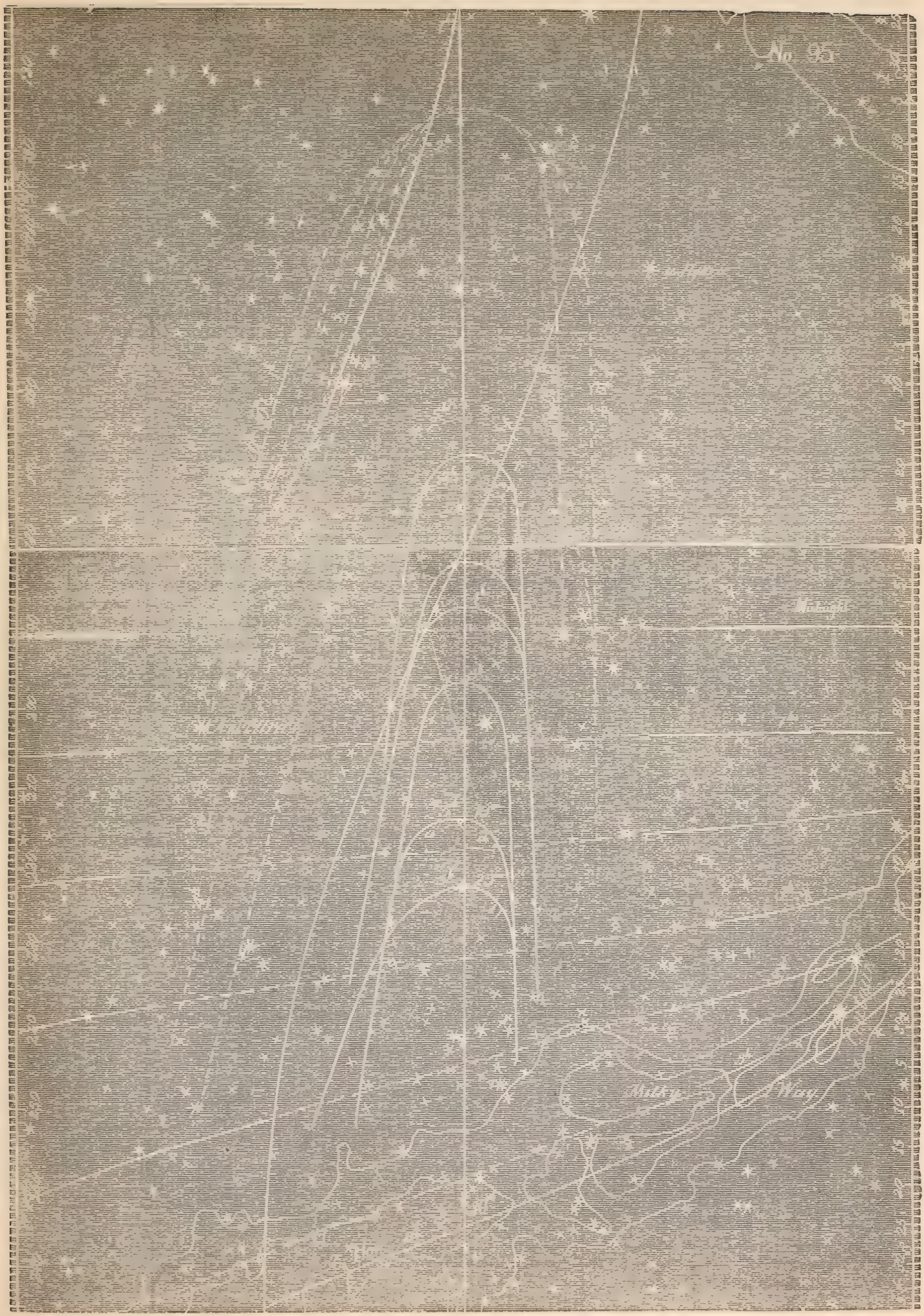
Western Zodiacal Light 0*h*. 15*m*. and 1 o'clock.

The evening of the 31st was cloudy; yesterday was Sunday. This morning I was on deck a few minutes after midnight, and found the Zodiacal Light, both in the western and eastern sky, as on the 31st a. m. As regards the *western*, took outlines at 0h 15m; the Light was very dim; I thought that between α and ω Arietis, it was equal to that of the Milky Way about φ, ζ, and ω Andromedæ. At $12^h\ 30^m$, it seemed to be more decided than the Zodiacal Light in the eastern sky, but this was probably not real. At 1^h, it could still be seen; its limits, as in the morning chart at $12^h\ 15^m$. At 2^h nothing of it left. Query—does it *die* out, or remain to sink under the horizon? To-night I thought the former. The Pleiades, its upper end, were, however, approaching the horizon at 2 o'clock, and its disappearance might have been owing to the horizontal haze or dimness.

The night was a most favorable one; stars were bright; scarcely a breath of air stirring.

At $12^h\ 10^m$, there seemed to be a dim Zodiacal Light in the eastern sky. I was not then fully decided about it, but, as afterwards I saw it gradually growing into the certain Zodiacal Light, of which at 1 o'clock there could be no doubt, I felt satisfied that this at $12^h\ 10^m$ was truly that Light. At 2^h the Stronger Light was decided enough to give boundaries. For the rest, see chart. The sinking of the Stronger Light at $5^h\ 10^m$, was remarkable;—it was so sudden, as was also the change in the strength of the Light. At 5^h I was admiring its brilliancy, and thought it was stronger than at any previous time that morning; just before $5^h\ 10^m$, it began to sink, and in two minutes' time had got to the limits given in the chart (marked $5^h\ 10^m$), and had lost more than half of its intensity: it was, indeed, now rather dim. At $5^h\ 25^m$, it had got still lower—same strength as at $5^h\ 10^m$. At $5^h\ 33^m$ dawn had come. While the Stronger Light was changing thus, the Diffuse remained the same as before, both in strength and boundaries.

[P. S., 1856.—I had prepared my chart with both the eastern and western Zodiacal Light upon it, at $12^h\ 15^m$ and 1 o'clock, but find it impossible to enter it in this book. The vertices of the eastern and western Lights were then 75° apart, not cusp-shaped, but rounded upwardly. The western Light extended to the Pleiades, and at its base reached $17\frac{1}{2}°$ N., and 15° S. of the ecliptic.]


No 95
Milky Way

No. 96.

JANUARY 2d, 1854 : Evening.

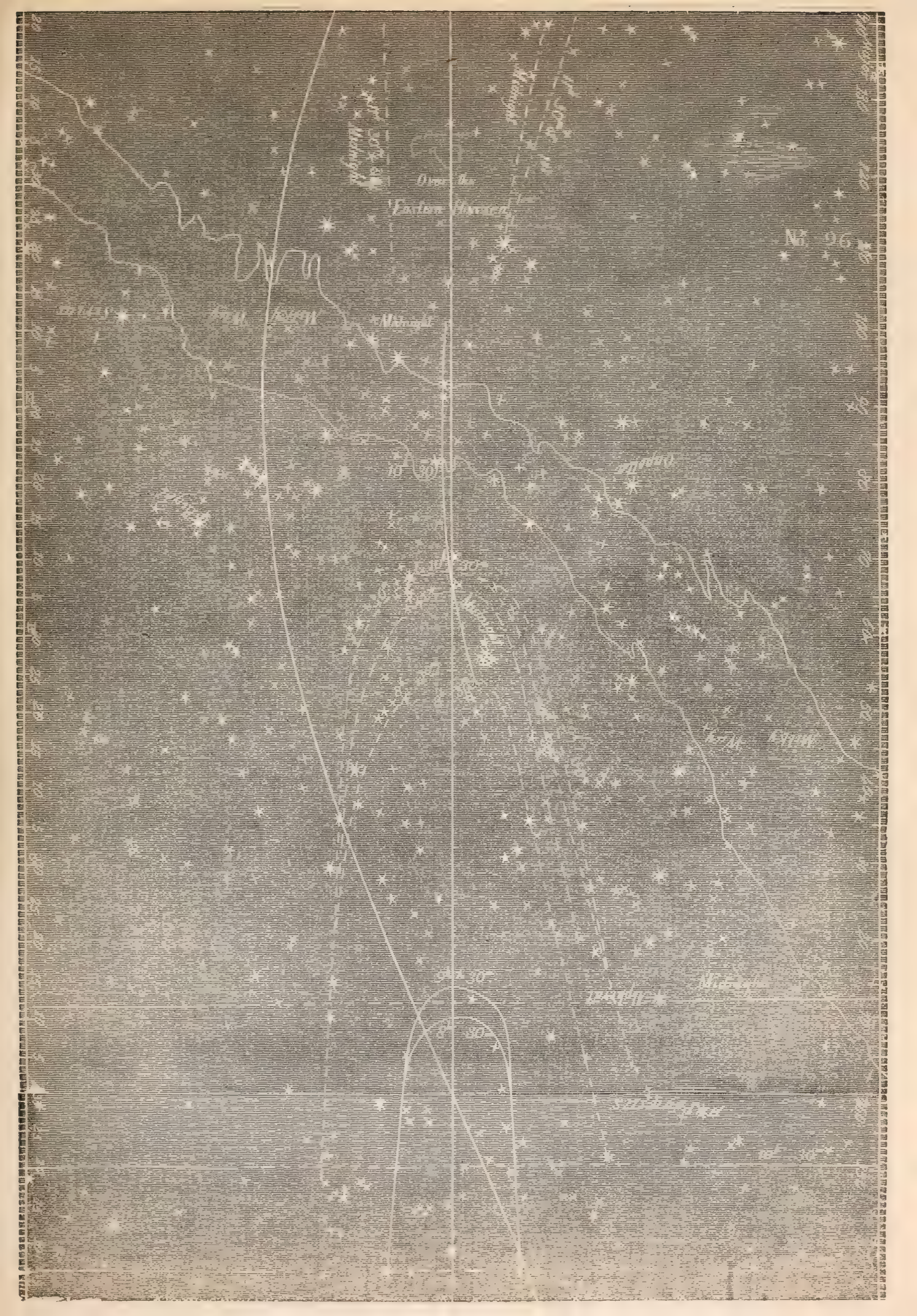
Lat. 22° 18′ N. : Lon. 114° 10′ E.

Sun set 5*h*. 24*m*.

Eastern Zodiacal Light at 11*h*. 30*m*. and midnight. Western Stronger Light 8*h*. 30*m*. Diffuse 8*h*. 30*m*.

Western Stronger Light	Diffuse
9 30	9 30
	10 30
	Midnight
	1 0

Moon till about 8^h 30^m. At that hour got observations. The night remarkably fine, sky clear, atmosphere transparent, no wind. At 9^h 30^m, the Stronger Light was dim, but I was able to get boundaries. At 10^h 30^m, it was gone; 11^h 30^m, boundaries same as at 10^h 30^m. At 12^h (midnight), the Light was dim, but still distinct. Between α and 73 Arietis, along on the ecliptic, the Light was equal to that of the Milky Way adjoining Betelgueux. At 11^h 30^m, saw also the Zodiacal Light in the *east*, for which see morning annotations, and also its boundaries in the evening chart. At 12^h, the Light in the east and west was about equal. At 1 a. m., the western Light still visible, but scarcely to be made out; its boundaries as at 12^h. At 1^h 45^m, nothing of it to be seen. It dies out; for the space below the Pleiades, at this hour, was free from haze quite to the horizon, yet was dark like the rest of the sky.


Eastern Horizon
Western Horizon
Meridian
Ecliptic
Milky Way
Southern Horizon

No. 97.

JANUARY 31, 1854: MORNING.

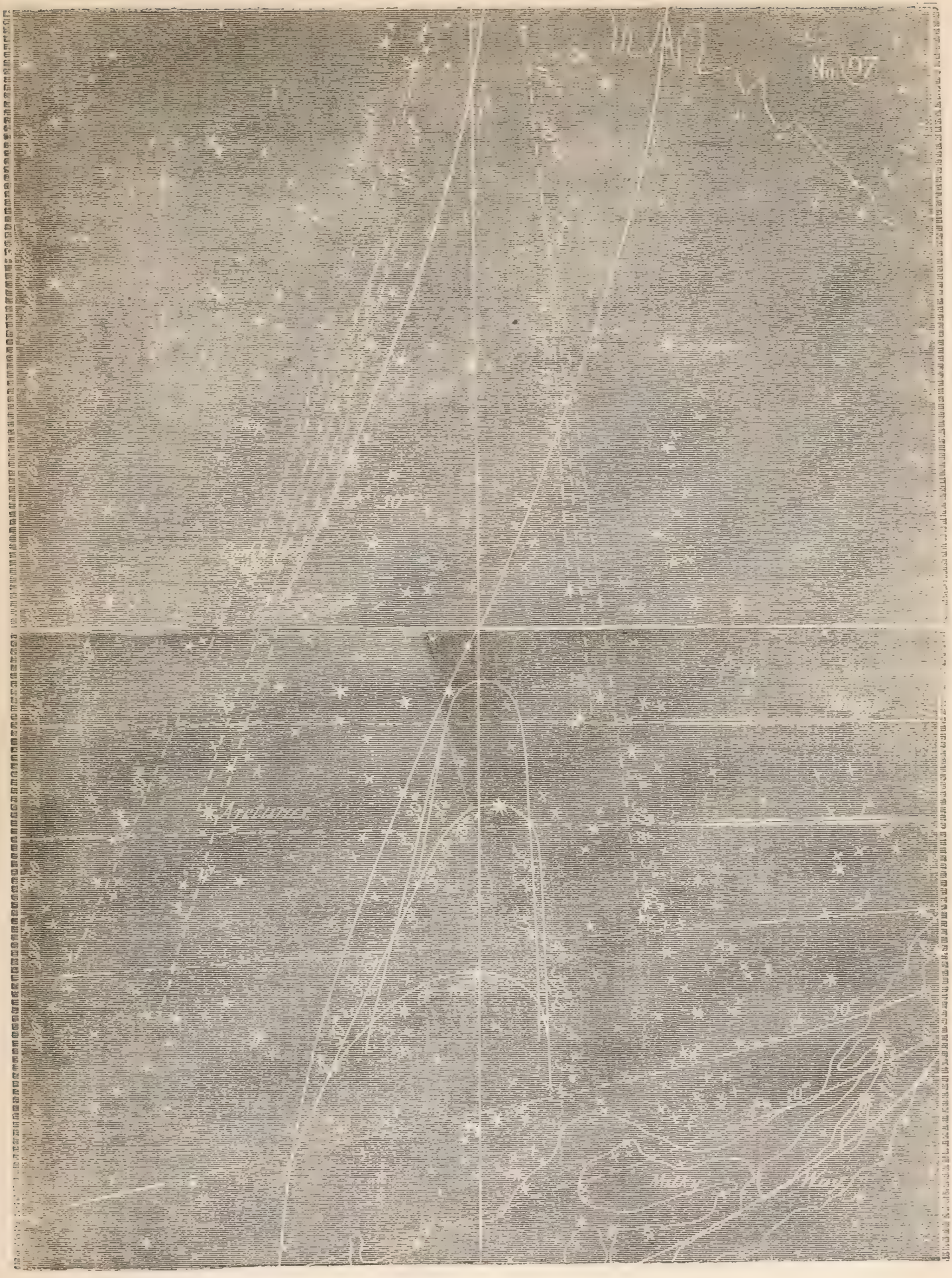
Lat. 22° 18′ N.: Lon. 111° 10′ E.

Sun rose 6*h*. 43*m*.

Western Zodiacal Light at midnight and 1 o'clock. Eastern, Stronger Light at 2*h*. 0*m* Diffuse 11*h*. 30*m*.

3	30		Midnight
4	30	1	0
5	5	2	0
5	10	3	30
		4	30
		5	10

As mentioned in the annotations of last evening, the eastern Zodiacal Light showed itself at half an hour before midnight, very faint, but still visible. Its northern limits were easily made out, but there was a difficulty in getting those towards the south; also it was difficult to say where it terminated above. At 12^h, it was as bright about 77 Leonis Majoris (a a in the chart) as the Milky Way close to Betelgueux. At 1^h, it was more distinct, but still dim. The night was remarkably favorable for observations. The Stronger Light showed itself at 2^h, but was dim. I was puzzled all through the morning's observations, by what seemed to be a narrow streak of the Diffuse Light, bounded by Pollux on one side, and the ecliptic on the other, and continued above Præsepe, seemingly to the Milky Way. But this was all very uncertain. Still it forced itself on my notice again and again. I did not know what to make of it. It seemed to be, and seemed not to be. Between 5^h 5^m and 5^h 10^m, the Stronger Light dropped down as shown in the chart. I watched it as it evenly but rapidly sunk; what remained also losing half its late brilliancy. After this, there seemed to be pulsations in the strength of this Stronger Light; it kept its boundaries as at 5^h 10^m, but seemed to increase and to fail in strength at intervals of five minutes or so; never, however, getting to the intensity which it had just before 5^h 5^m. Dawn at 6^h 30^m.


Andromeda

No. 98.

JANUARY 3d, 1854: Evening.

Lat 22° 18′ N.. Lon. 114° 10′ E.

Sun set 5*h*. 25*m*.

Eastern Zodiacal Light at 11*h*. 20*m*. and midnight. Western, Stronger Light at 9*h*. 40*m*. Diffuse 9*h*. 20*m*.

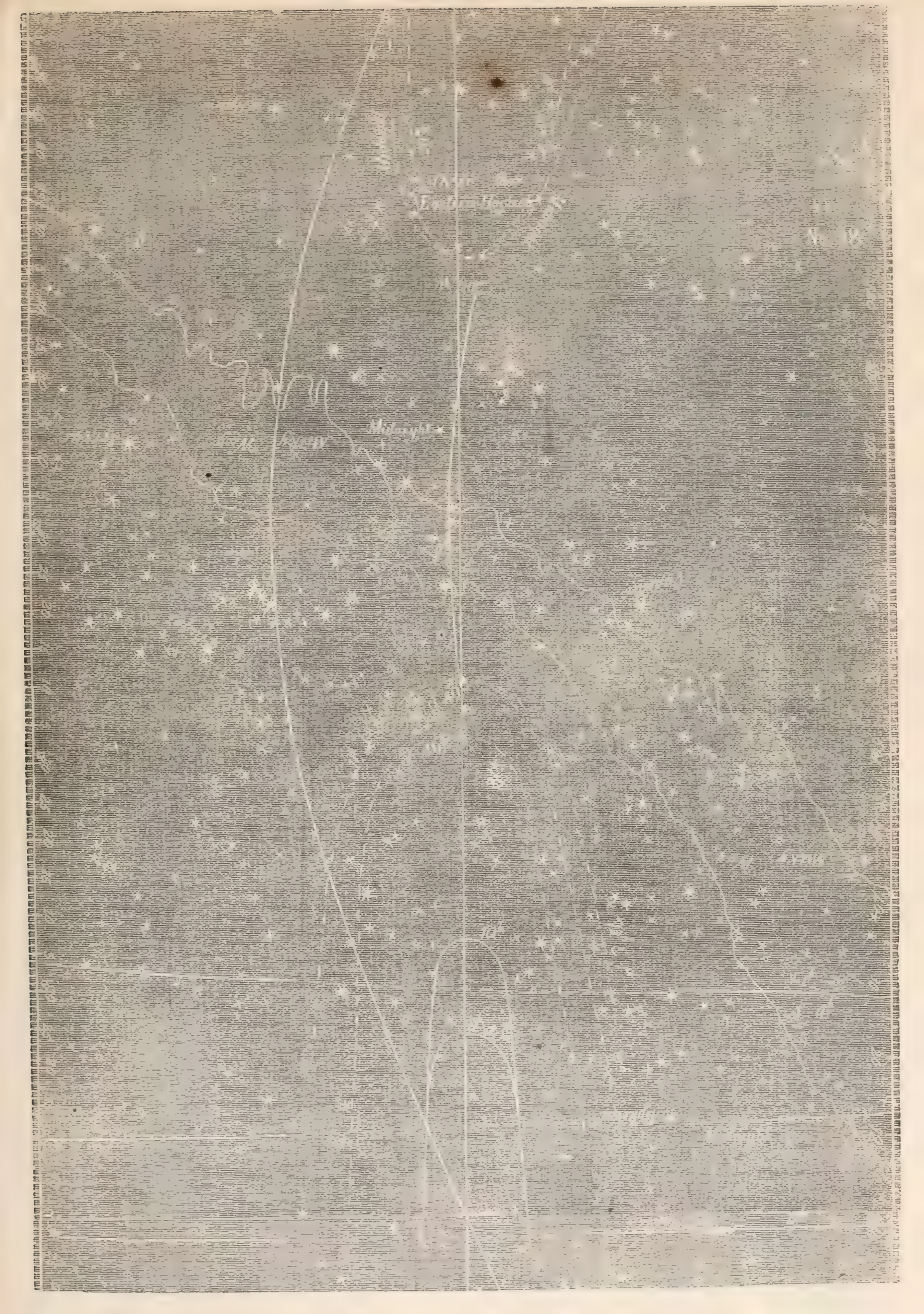
10 0 10 0

Midnight

1 o'clock.

Moon interfered till some time after nine. At 9^h 40^m got observations. Night a most favorable one, calm and very clear; sky brilliant. For observations, see chart. At 12^h (midnight), the Light was still very decided in the west—quite distinct. At 1^h a. m. there was the slightest possible tinge; same boundaries as at 12^h. At 1^h 23^m the western Zodiacal Light was still visible, but very faint; no boundaries could be got. At 1^h 32^m it was gone. There was then a slight haze along the western horizon, but not high; and there was no light between it and the Pleiades The Zodiacal Light had evidently *died out*.

At 11^h I turned to the eastern horizon to observe there also. My notes are as follows. "At 11^h, there seems to be a faint tinge in the eastern sky, as high as Præsepe, and with the usual Zodiacal Light boundaries; but cannot speak positively—not certain. At 11^h 20^m, I think I can speak positively; got boundaries; 11^h 30^m, it seems to be quite certain; the Light about Mars—*i. e.* above 77 and 78 Leonis Majoris—is equal to that of the Milky Way close to Procyon, but has the warm tinge of the Zodiacal Light; the western Light is of the same strength; 11^h 40^m, the eastern Light is certain now; it is stronger than that in the west." All this gradual growing, with the certainty at 11^h 40^m, makes it, I think, sure that I saw it at 11 o'clock. As the western Light continued till 1^h 23^m a. m., both eastern and western Lights were, consequently, simultaneously visible for two hours and twenty-three minutes.



No. 99.

JANUARY 4th, 1854: Morning.

Lat. 22° 18′ N.: Lon. 114° 10′ E.

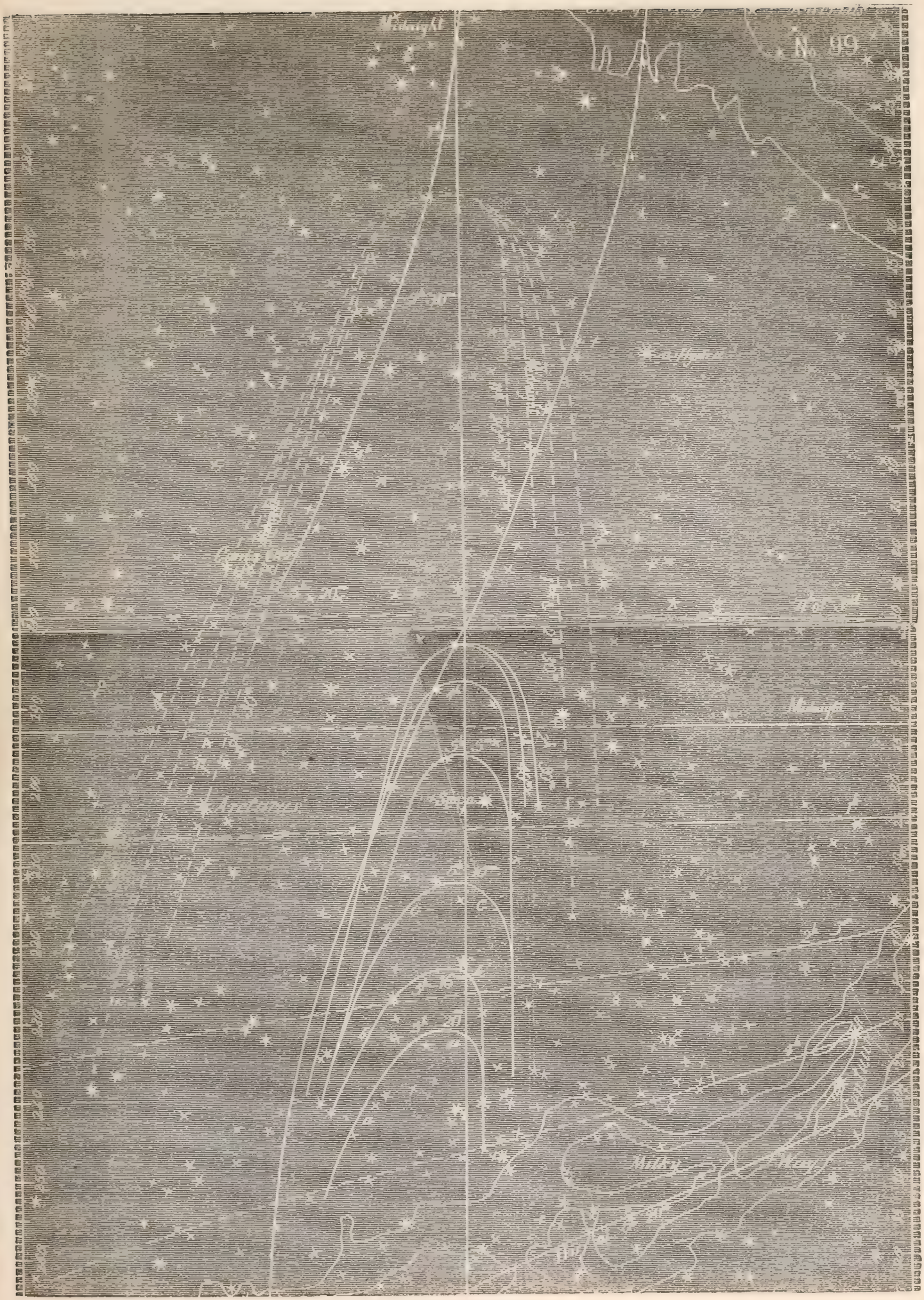
Sun rose 6*h*. 44*m*.

Western Zodiacal Light at midnight and 1 o'clock. Eastern Stronger Light 1*h*. 40*m*. Diffuse 11*h*. 20*m*.

2	30	Midnight.
4	0	1 0
5	5	2 30
5	10	4 0
5	16	5 0
5	20	

The western Zodiacal Light continued until 1^h 23^m of this morning, as is noted in the evening record of January 3d. The *eastern* Zodiacal Light began to appear at 11^h, though it was but a very faint tinge. I was doubtful of it; but having watched it as it increased in brightness, till at 11^h 40^m there could be no doubt of it, I think it may be considered certain that it was seen at 11 o'clock. Took boundaries at 11^h 20^m, &c., as in the chart. As the morning advanced, the Stronger Light seemed to slide to the northward, and it will be seen from the chart that the inclination of the ecliptic to the horizon was then diminishing very rapidly. After 5^h 5^m, I was looking at the Stronger Light, and, not aware that the minutes had passed so rapidly, was not expecting any sinking of the Light yet; when I noticed suddenly that it was no longer in its late position, but had sunk to *c c;* on looking at my watch, I found it was the time for it; it was now 5^h 10^m. It had also but half its late intensity. This diminishing in height and intensity could have occupied little more than a minute. At 5^h 16^m it had got down to *b b*. Then, very soon, it began to ascend, also brightening up, till it got one-third of the way from *b b* to Spica, when it sunk rapidly again, and at 5^h 20^m had got to the position given in the chart, *a a*, also dimming again; thence it rose once more to *b b*, and at 5^h 26^m had sunk again to *a a*, brightening and dimming as before; then it ascended once more to *b b*, brightening as it rose; and at 5^h 31^m it was down again to *a a*. At 5^h 32^m the light broke bounds, and dawn had arrived. In these pulsations, the *increase* in height and strength of brightness was much slower than the *decrease*.

I ought to remark, that, although from 4^h 30^m to 5 o'clock, the Stronger Light is quite strong, it has never the great brilliancy of the morning Light in September and October. This will apply also to the intensity in the present evening observations.


Midnight
No. 99
Midnight
Arcturus
Milky Way

No. 100.

JANUARY 5th, 1854 : Morning.

Lat. 22° 18′ N. : Lon. 114° 10′ E.

Sun rose at 6*h*. 44*m*.

Western Zodiacal Light at	Eastern, Stronger Light	Diffuse	Paled sky at
11*h*. 0*m*. Midnight.	1*h*. 0*m*.	11*h*. 0*m*. Midnight.	1*h*. 25*m*.
1 0	1 30	1 0	5 0
	3 0	1 30	
	4 45	3 0	
		5 0	

The moon did not set till about 11 o'clock. At that hour got an observation in the west, and found the Zodiacal Light also quite decided in the *eastern* sky. At 11^h 15^m the western Zodiacal Light between α and 78 Arietis was equal to that of the Milky Way at 51 and 54 (right foot) Andromedæ, but it was of a warm cast. The eastern Zodiacal Light was of about the same strength. At 12^h the boundaries were as before, but the Light was dim. At 1^h 5^m it was still distinguishable; at 1^h 20^m all was gone.

[P. S., 1856.—The want of room in the chart here given prevents my giving the boundaries of this western Light noted above. It extended as high as Aldebaran, and at the western horizon, at midnight, reached 16° S., and 23° N. from the ecliptic. The vertices of the eastern and western Zodiacal Lights at 11 and 12 o'clock were 51° apart.]

The *eastern* Zodiacal Light was quite decided at 11 o'clock last evening; its strength is referred to above. At 12^h (midnight), it was still the same; took boundaries also at 1^h and 1^h 30^m. At 1^h 25^m and 1^h 30^m the sky was paled to the dotted line. Got the Stronger Light at 1^h and 1^h 30^m. I meant to get boundaries at 4^h, but slept so soundly that the orderly's call did not rouse me till towards 5^h. At 5^h there was a paled sky beyond the Diffuse bounds, of which I have given limits in dotted lines. Above the limits of the Diffuse Light, as given at 5^h, there *seemed* to be a strip of paled sky; could not see how far up it went. At 5^h thin clouds came floating over, and stopped reliable observations. I could see between the clouds that the Stronger Light sunk, and seemed to pulsate, as yesterday morning. At 5^h 15^m, as the clouds were obstinate, and would not admit of any definite results, I left the deck.

Nov. 30th
Midnight
Milky Way
Ursa Major
Ursa Minor
Cassiopeia
Perseus

No. 101.

JANUARY 6th, 1854: Morning.

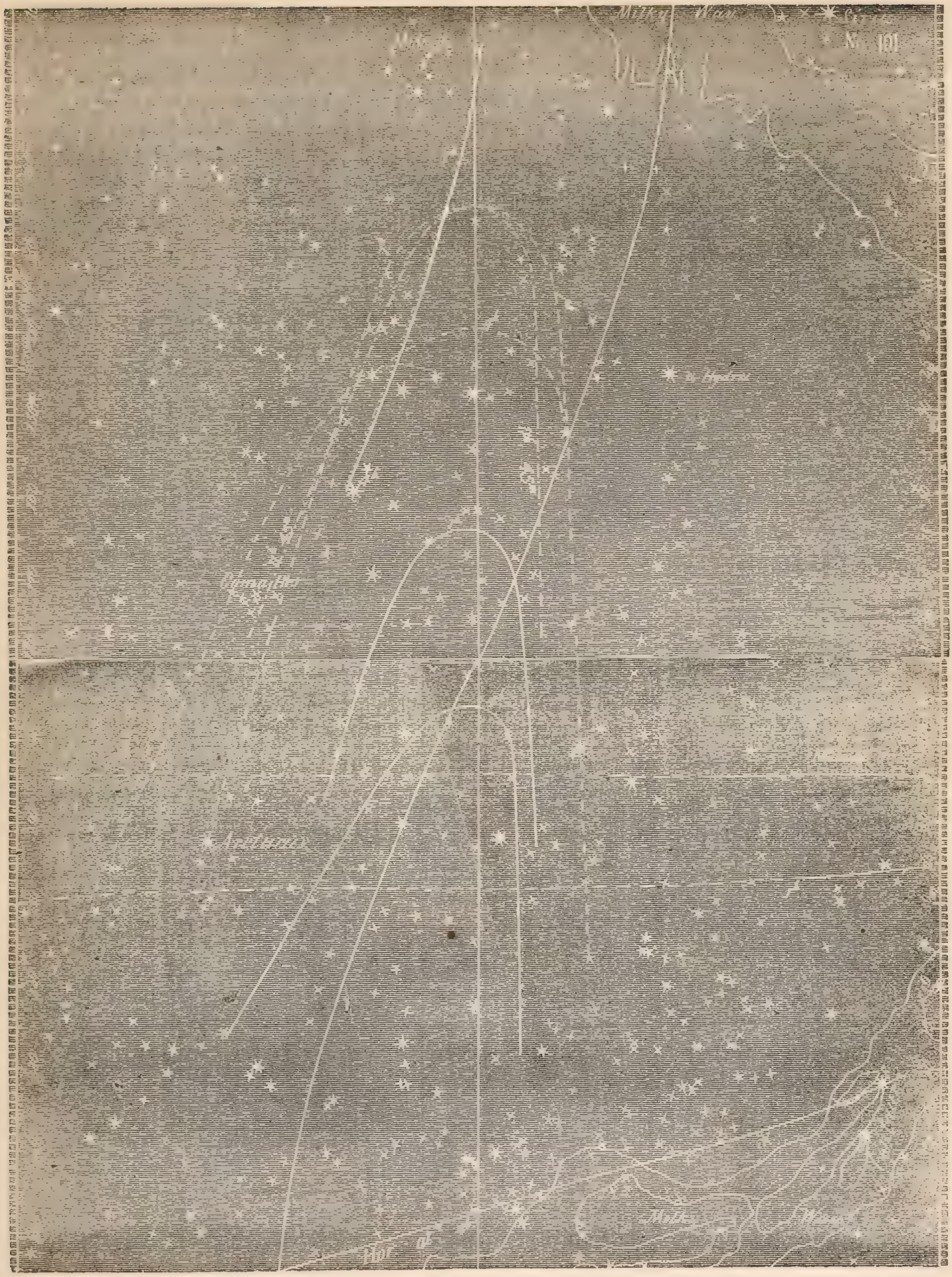
Lat. 22° 18′ N.: Lon. 114° 10′ E.

Sun rose 6*h*. 30*m*.

Western Zodiacal Light at 11*h*. 45*m*.	Eastern, Stronger Light 1*h*. 0*m*.	Diffuse 11*h*. 45*m*.
	4 0	1 0
		4 0

Moon did not set till very late. At 11^h 45^m got observations; Zodiacal Light still in the west, as per chart. At 1^h clouds prevented observations in that direction. At 11^h 45^m got boundaries also in the east; so also at 1 o'clock, together with Stronger Light. Clouds at 2^h. At 4^h got observations as in the chart; while finishing them, the sky was clouded over; so it remained till dawn.

[P. S., 1856.—My space here is too contracted to allow my inserting these western boundaries. In my original chart they reached within 2° of Aldebaran, and at the base extend to 17° N. and 15° S. of the ecliptic. The distance between the vertices of the eastern and western Lights at 11^h 45^m was 58°. These vertices are not cusp-shaped.]



No. 102.

JANUARY 10th, 1854: Morning.

Lat. 22° 18′ N.: Lon. 114° 10′ E.

Sun rose 6*h*. 46*m*.

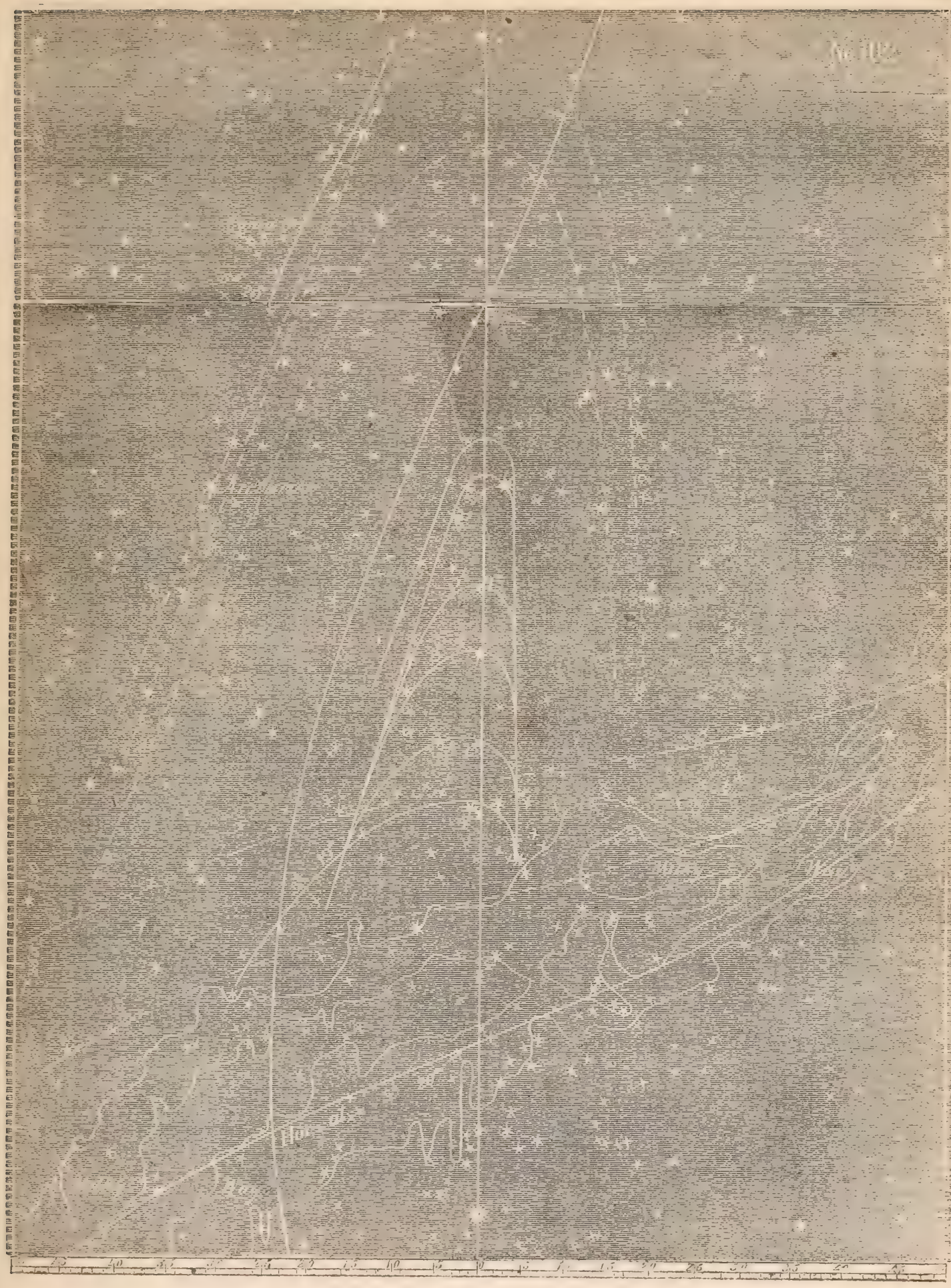
Stronger Light at		Diffuse	
3*h*.	0*m*.	3*h*.	0*m*.
4	0	4	0
5	0	5	0
5	5		
5	7		
5	12		
5	19		

Clouds since last date (6th). Moon set just before 3 o'clock. At 3^h, &c., had observations, for which see chart. I watched very carefully at 3^h, 4^h, and from 5^h on, to see if there were any pulsations. Nothing till after 5^h. At 5^h the Stronger Light was very bright, and extending up to Spica, though dimmer at its upper end; at 5^h 5^m it had sunk to α Libræ, and had become greatly dimmed; had about half its former brightness. At 5^h 7^m it seemed to have ascended about 9°, and to have brightened some; at 5^h 12^m it was down to 38 Libræ, and had dimmed; it perhaps rose a little again, but of this I was not certain. At 5^h 19^m it was down to β and 6 Scorpionis, and had spread to the northward; it was now bright; at 5^h 23^m the light broke bounds, and dawn had come.

These risings and sinkings, and changes of intensity, are as they appear to me to be; but the upper limit of this Stronger Light is so indefinite, and the changes are of such an indefinite character, that I wish to speak of them somewhat doubtingly. Of the first sudden sinking and loss of intensity, I think, however, there may be no doubt.

The morning was remarkably favorable for observations; atmosphere clear, sky very bright, and very little haze on the horizon.

In September 2d, and October 4th, of last year, are notices of an increase of the Zodiacal Light after the first dimming. I remember noticing, not unfrequently last year, an apparent ascent of the Stronger Light after its sudden subsidence, and also, with this, an increase of light; but there seemed to be more uncertainty attending its character, and I believe I have neglected to take note of it.



No. 103.

JANUARY 11th, 1854: MORNING.

Lat. 22° 18′ N.: Lon. 111° 10′ E.

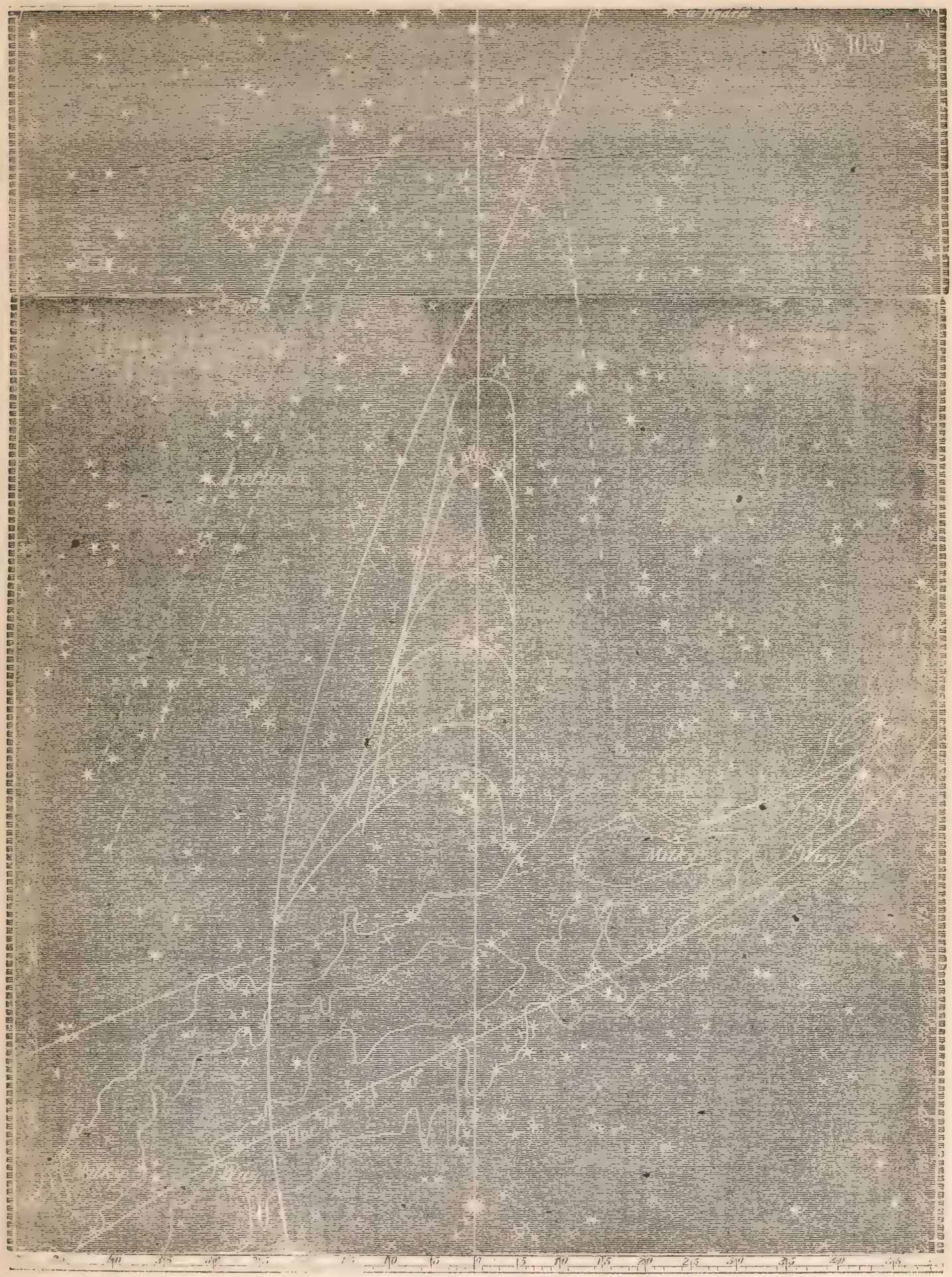
Sun rose 6*h*. 46*m*.

Stronger Light at 4*h*. 0*m*.	Diffuse 4*h*. 0*m*
4 40	5 0
5 0	
5 2	
5 7	
5 12	
5 14	
5 16	

Moon did not set till almost 4 o'clock. At 4^h got boundaries; and also at 5^h, as in chart. After 5^h, was carefully on the watch to see if there would be any pulsations. Morning very clear. Atmosphere transparent; every thing favorable for good observations. My notes run thus: "4^h 40^m, Stronger Light very strong and bright; 5^h 2^m, it has sunk, and has dimmed; 5^h 7^m, sunk lower, dimmed to half its former brightness; 5^h 12^m, has risen, and has just sunk again (for its latter place, see chart); 5^h 14^m, up again, and has brightened; 5^h 16^m, is up now to α Libræ; 5^h 22^m, breaks bounds, and dawn has come. In breaking bounds, it spreads first and most rapidly towards the north; then southwardly." These are my notes—for so it seemed to me; but, after all, these pulsations may only be seeming ones. I do the best I can, in watching carefully, and recording what *appears* to be. One thing I can say with certainty: namely, that there is first a sudden and very rapid sinking down of the Stronger Light, with a dimming to about one-half of its late intensity; and then, a little while before dawn, a rising again of the Stronger Light, with an increase of brightness, though not coming up to its former strength. Of so much I can be positive.

This morning I concluded to watch after dawn had come; for the Light, though spread over the whole eastern sky, was yet strongest at the central line of the late Zodiacal Light; as if, while the sunlight had now reached our atmosphere, and was reflected from *it*, the reflection was still strongest from the substance giving the Zodiacal Light. At 5^h 25^m a little of this was still left—say from 38 Libræ down; 5^h 28^m, some slight trace of it still remained; 5^h 30^m, all gone; sky uniform.

All this corresponds conversely to the first appearing of the Zodiacal Light in the evening sky, as I have often described it; the time when I suddenly become conscious that I am looking on the true Zodiacal Light, corresponding to the morning period just before the time when the Light breaks bounds, and becomes mingled with the dawn light—*i. e.* light from our atmosphere.

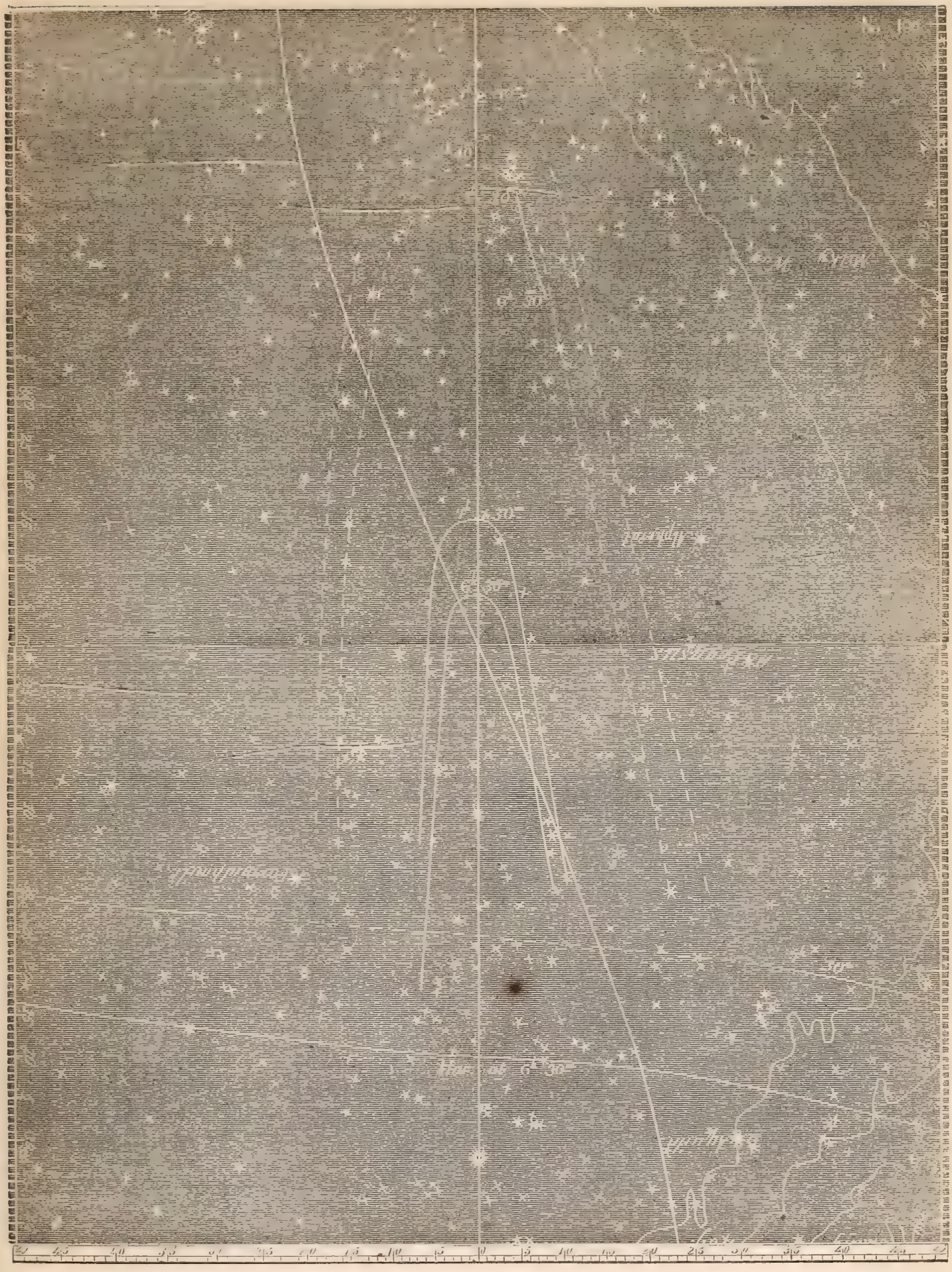


No. 104.

JANUARY 18th, 1854 : Evening.

Lat. 23° 40′ N : Lon. 123° 28′ E.
Sun set 5*h.* 33*m.*
Stronger Light at 6*h.* 30*m.* and 7*h.* 30*m.* Diffuse 6*h.* 40*m.* and 7*h.* 30*m.*

Clouds since the 11th until this evening. To-night was able to get brief, but fair views of the western sky, and had observations at $6^h\ 30^m$ and $7^h\ 30^m$. Soon after this, the moon rose. Was watchful to try to get moon Zodiacal Light, but clouds overspread the sky just before the time, and I was disappointed.

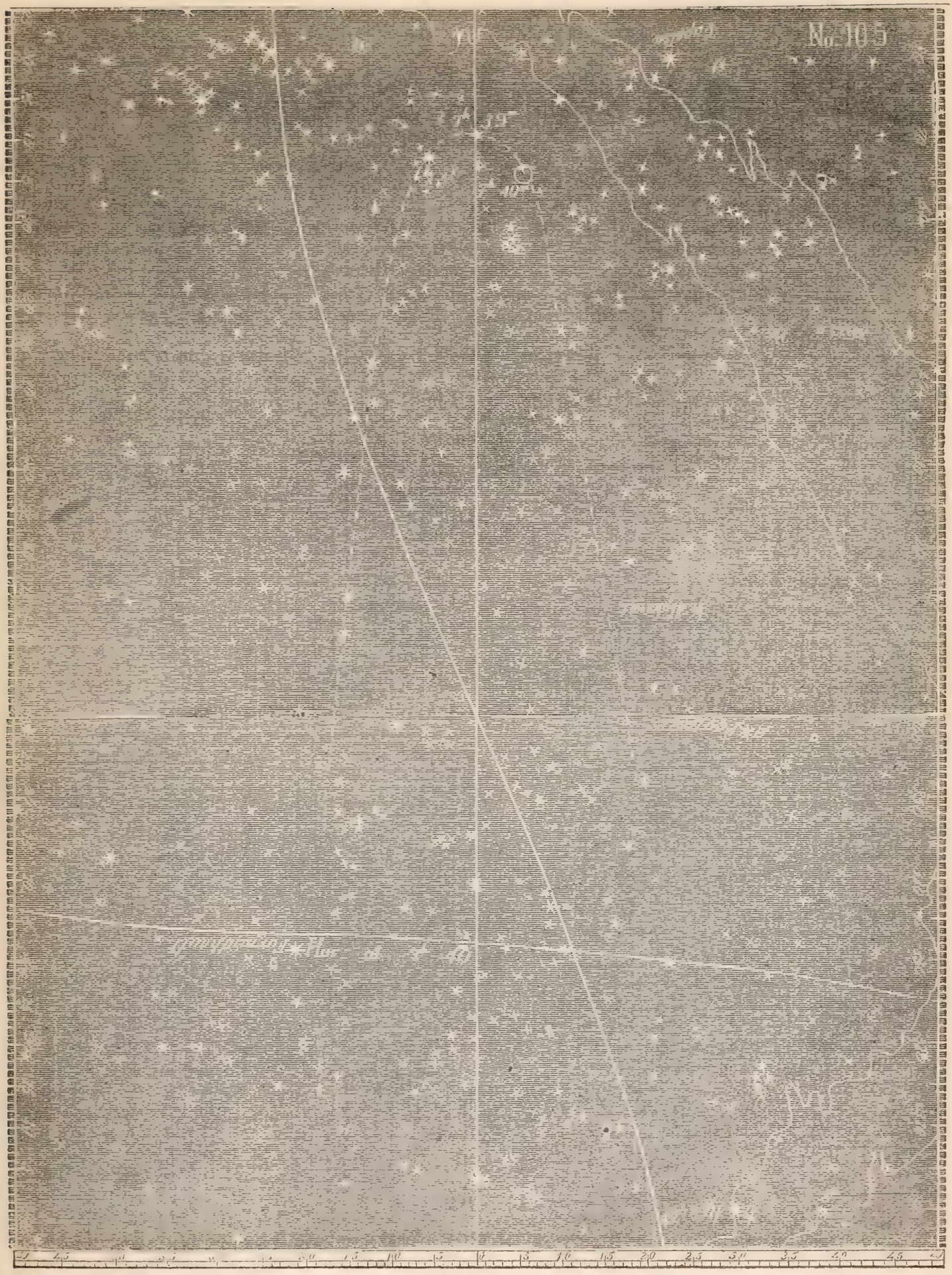


No. 105.

JANUARY 24th, 1854 : EVENING.

Lat. 26° 10' N.: Lon 127° 42' E.
Sun set *5h. 33m*
Diffuse Light at *7h. 39m.*

Loo Choo.—Clouds since the 18th, except Sunday evening. This evening, in a brief interval between the clouds, got an observation at $7^h\ 39^m$; could get no more. The sky is almost constantly covered with *ever shifting* clouds.

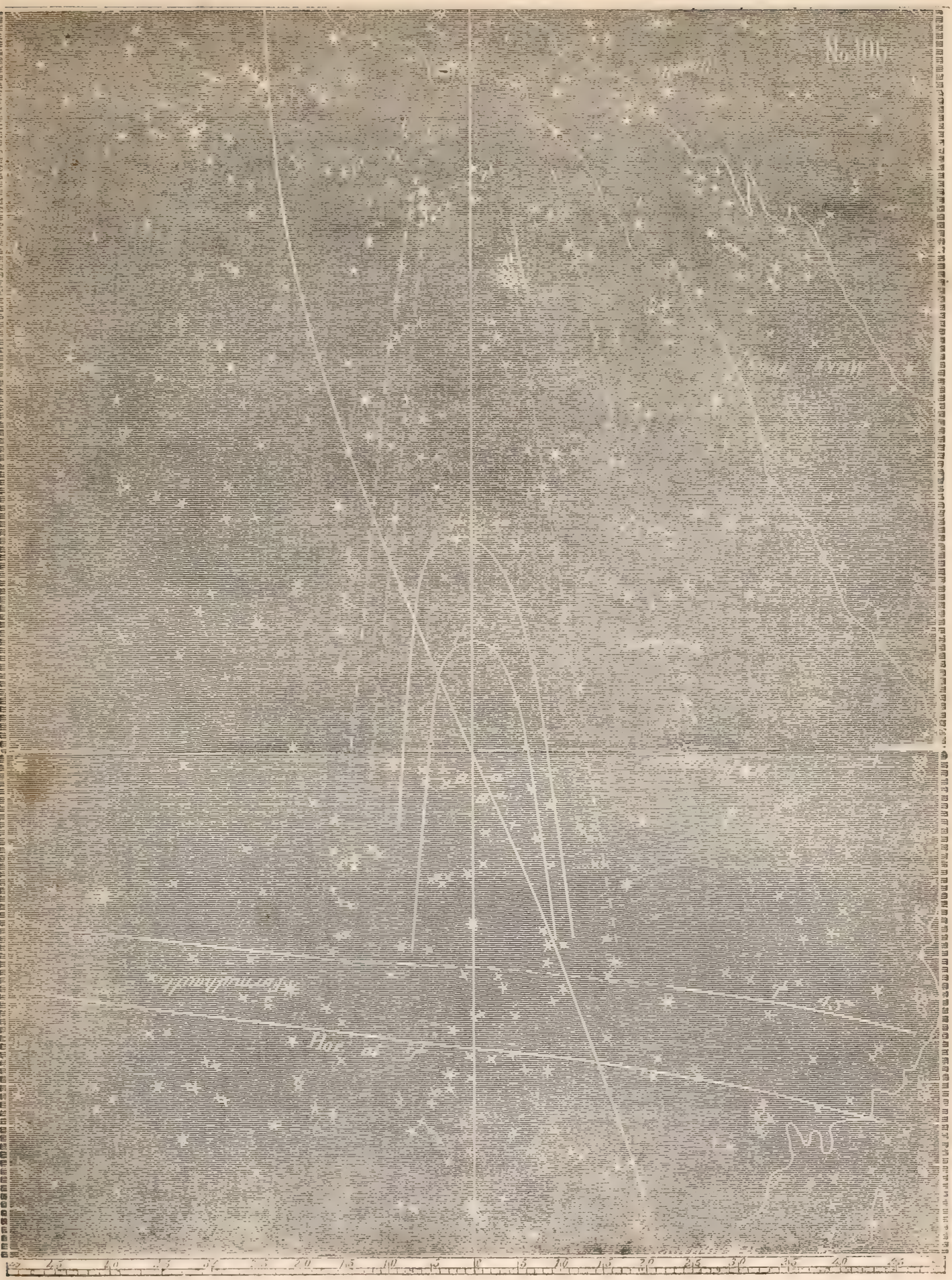

No. 105

No. 106.

JANUARY 25th, 1854: Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.
Sun set 5*h.* 33½ *m.*
Stronger and Diffuse Light 7*h.* and 7*h.* 45*m.*

A most changeable sky; at one time large portions of it are clear, and then, immediately after, it is covered all over with clouds. Watched for clear intervals, and got two observations as in the chart; the western speck of the sky, at these times, was remarkably clear. At 7ʰ 50ᵐ the Stronger Light was very bright, indeed, at the spot marked *a a a* in the chart; and below this, it was brighter than any part of the Milky Way then above the horizon. The sky was clouded over immediately after 7ʰ, and I could get no further observations during the night.


No. 107.
Aquila
Ophiuchus
Ara
Scorpio
Libra
Virgo

No. 107.

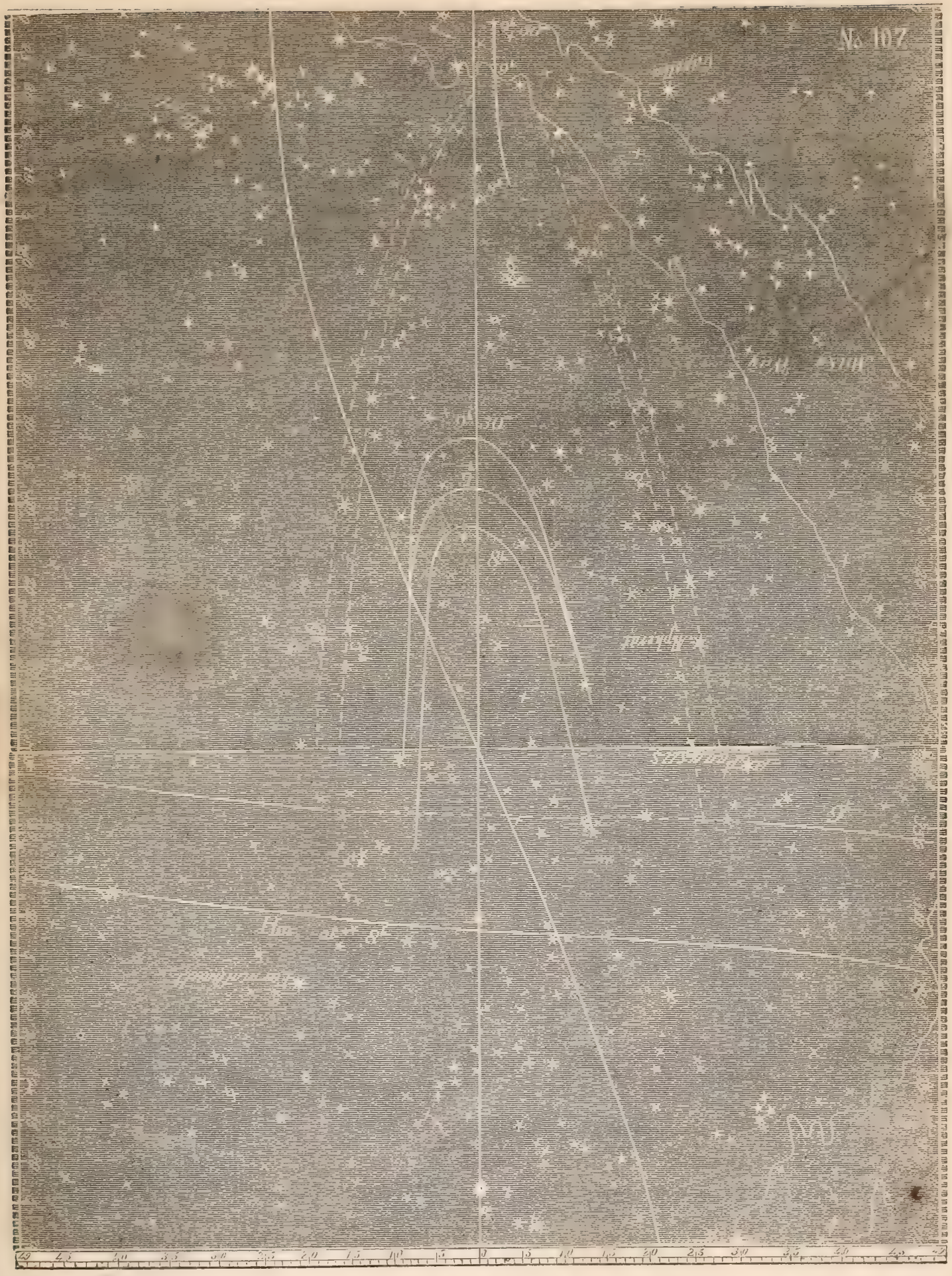
JANUARY 26th, 1854: EVENING.

Lat. 26° 10′ N.: Lon. 127° 42′ E.

Sun set 5*h*. 35*m*.

Stronger Light { 8*h*. 0*m*. / 9 0 / 9 30 } Diffuse, 8*h*. and 9*h*.

Blowing half a gale, as it has been ever since our arrival at Loo Choo. Now and then are openings to a clear sky; and at such intervals, this evening, I got observations of both the Diffuse and Stronger Light. At 8^h, this Stronger Light was very brilliant; just as if the sun were going to rise at that part of the sky. It is now much brighter than for a long time past. At 9^h, it was considerably dimmed. Might, perhaps, have got observations to a later hour; but as the Light then, on account of its dimness, would have required a good sky in order to get boundaries reliably, I made no further effort.

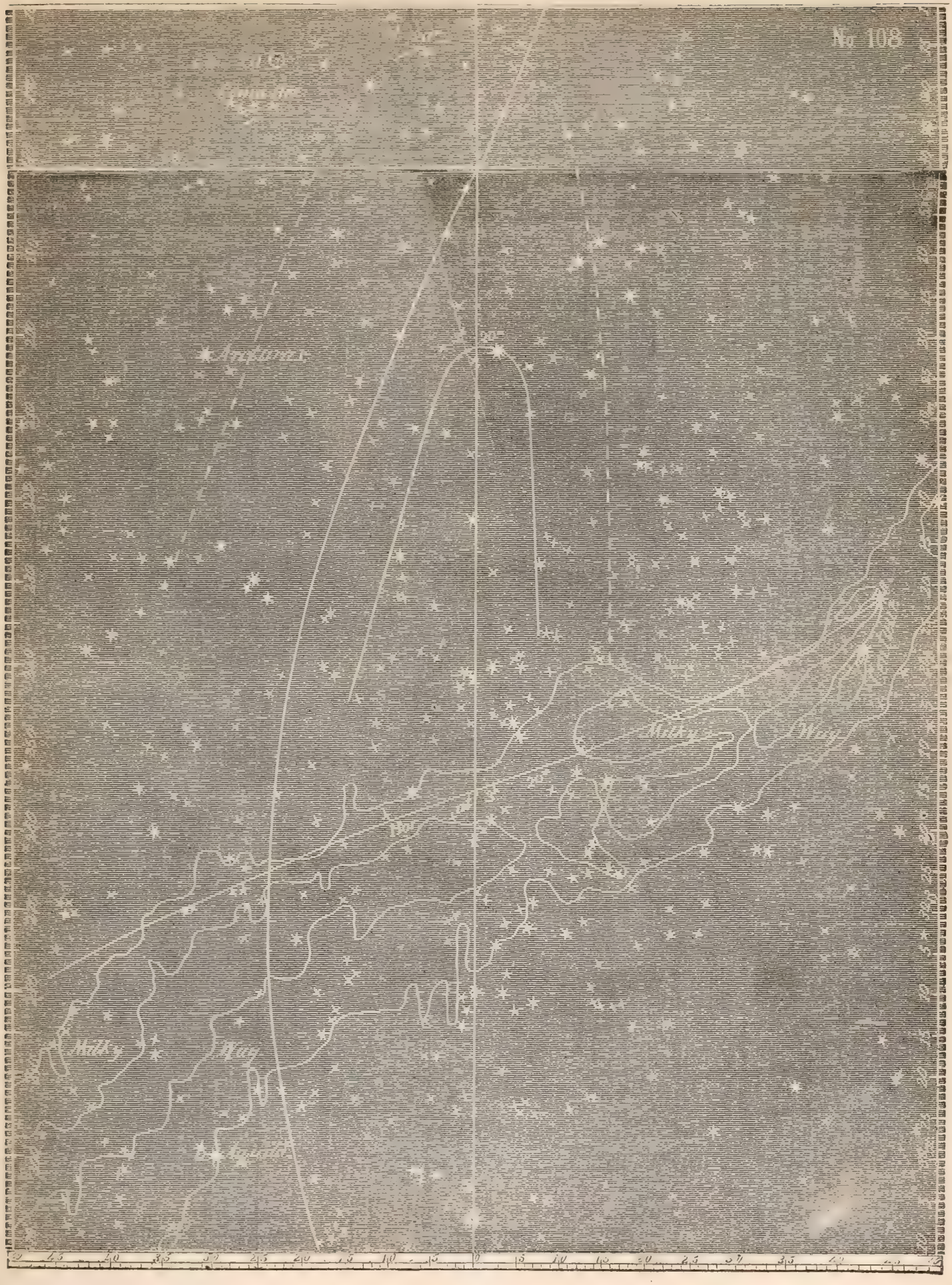

No. 107

No. 108.

JANUARY 27th, 1854: Morning.

Lat. 26° 10′ N.: Lon 127° 42′ E.
Sun rose 6*h*. 51*m*.
Stronger and Diffuse Light, 3*h*. 20*m*.

Waked at 3ʰ 15ᵐ, and found the sky perfectly clear, and very brilliant. Got an observation. Both the Diffuse and Stronger Light very decided. At 3ʰ 40ᵐ, the sky was all overclouded, and rain was pouring down. So changeful are the skies at this time.


No 108
Arcturus
Milky Way
Milky Way

No. 109.

JANUARY 27th, 1854: Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.
Sun set 5*h*. 35*m*.
Stronger and Diffuse Light at 7 and 8 o'clock.

Have been trying lately to watch the change from twilight into the Zodiacal Light, but have been baffled by the ever-shifting clouds. This evening the red light on the horizon, after sunset, changed gradually into a dull grey, evenly diffused: at $6^h\ 25^m$, this grey began to brighten up a little; and more so below Venus than in any other place: at $6^h\ 30^m$ it was bright, but still not Zodiacal—*i*, *e*., it was not confined to the Zodiacal Light bounds. Then clouds gathered over, and I could do nothing more till 7^m; at which time, and at 8^h, got boundaries as in chart. Then clouds again, which continued all the rest of the night. At 7^h the sky was remarkably bright and clear; and I noticed, what had struck me also for two or three nights before, that the Stronger Light tapered off gradually above; thus running into a sharp cone. At 8^h, that part of the sky was obscured by clouds, and I could not see whether the Zodiacal Light yet continued or not.

No. 110.

JANUARY 30th, 1854 (Monday): Morning.

Lat. 26° 10′ N.; Lon. 127° 42′ E.

Sun rose 6*h*. 48½*m*.

Stronger and Diffuse Light { 2*h*. 0*m*. / 3 0 / 4 0 / 5 0 } Paled sky 1*h*. 30*m*. and 4*h*. 0*m*.

Clouds from the 27th till last evening. Rose at midnight, but the sky was cloudy. Was called at 1ʰ 15ᵐ, and found the sky clear, except a cloud at the east, which was sinking towards the horizon, (1ʰ 15ᵐ no Light in the *west*.) When it had sunk sufficiently at 2ʰ, got observation; also at 3ʰ, 4ʰ, and 5ʰ. Sky very clear, and good for observing. There was a paled sky beyond the Diffuse, of which I have given outlines at 1ʰ 30ᵐ and 4ʰ. Am not quite certain that this went up as high as the Milky Way, but thought it did. There is a broad streak of sky from Regulus up to the Milky Way, within the dotted lines, which puzzles me. I cannot make out whether its peculiar appearance is owing to the Zodiacal Light, or to a want of stars and a steady paleness or dimness there.* From Præsepe up, however, it seems to amount almost or quite to a positive light, like the Diffuse Zodiacal Light. At 3ʰ, 4ʰ, and 5ʰ, however, I could not see it higher than nearly to Regulus. But these palenesses are all so indefinite, that it is often difficult to get their boundaries; and at 2ʰ it was difficult to get the limits of the Diffuse Light within the paled sky. At 2ʰ got the Stronger Light, but it was dim.

It is worth noticing how, as the hours pass, and the ecliptic becomes rapidly more and more inclined to the horizon, the Zodiacal Light, both Diffuse and Stronger, but more especially the latter, slides over towards the left, or north.

At 5ʰ, the Milky Way was some distance above the horizon, and the Stronger Light was very evidently crossing it, and making itself as marked in its boundaries as if there were no Milky Way there.

At 5ʰ 20ᵐ dawn.

* P. S.—See entry of February 15th, instant.

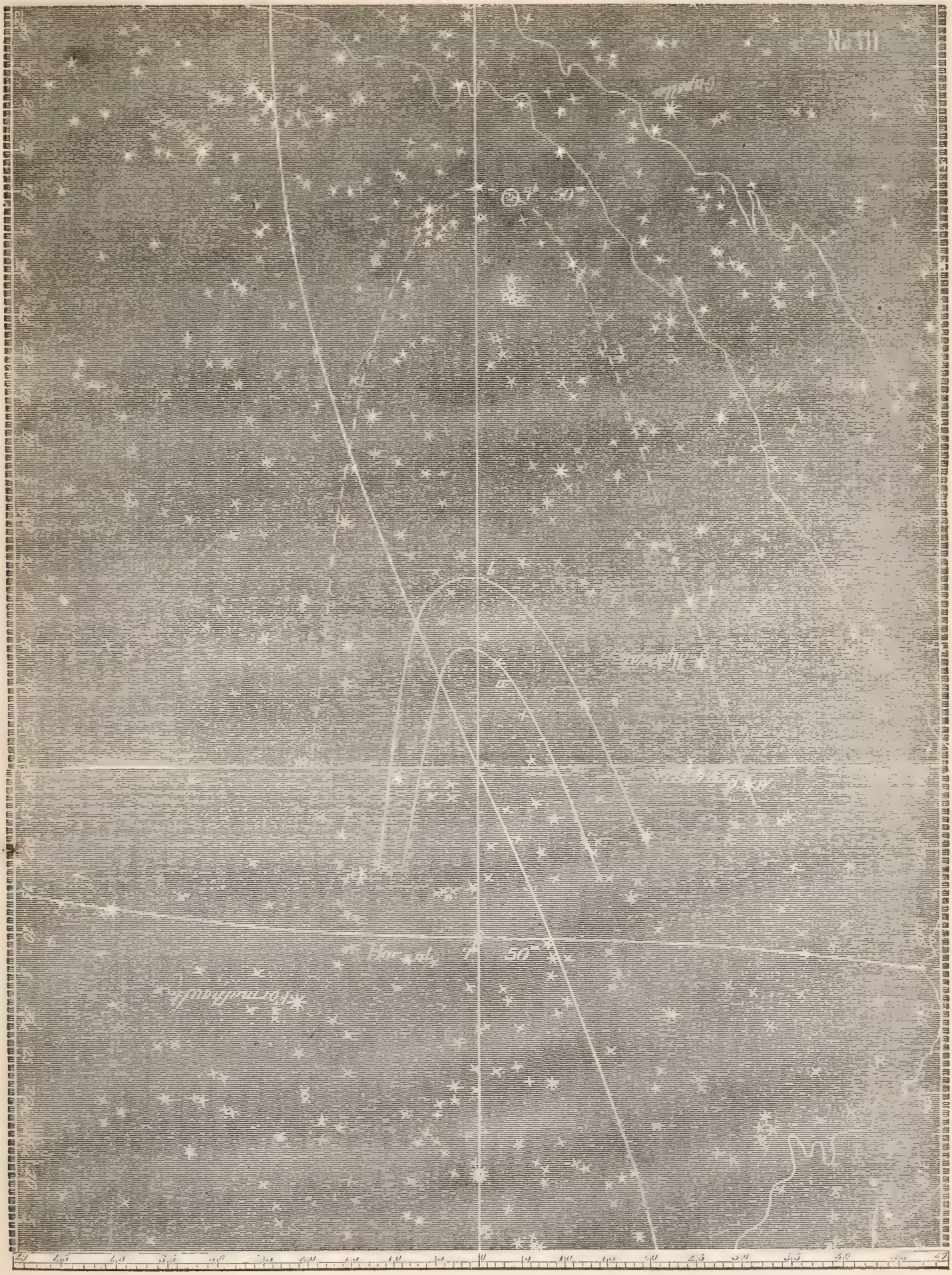
No. 111.

JANUARY 30th, 1854: Evening.

Lat. 26° 10′ N.: Lon. 127° 42′ E.
Sun set 5*h*. 38½*m*.
Stronger Light 7*h*. 50*m*, &c.: Diffuse, 7*h*. 50*m*.
Sun's lon. 310° 20′.

There can be no doubt that there are pulsations in the Zodiacal Light. I noticed them last evening (the sky being very clear); but, it being Sunday, made no particular record of them. They were, however, distinctly to be seen; and when I called the attention of one of the quartermasters to them, he very easily made them out. His language about the Light was: "Now it seems to be dying away;" "now it is brightening again," &c. All this applied, however, only to the Stronger Light: it occurred between 7^h 30^m and 8 o'clock. This evening I was on the careful lookout for them, and, with watch in hand, made record of the changes and their times. Clouds interfered till 7^h 50^m, when, this part of the sky having cleared up, I got observations. The pulsations were very distinct; observable, however, only in the Stronger Light. This, at 7^h 50^m, had its boundaries as in the line *b* (see chart), and was very bright: at 7^h 52^m it had sunk to the boundaries marked *a*, and was very dim: 7^h 54^m had risen to *b* again, and was bright: 7^h 55^m at *a*, and very dim: 7^h 56 at *b*, and bright: 7^h 57 at *a*, and very dim: 7^h 58½^m at *b*, and bright: 7^h 59½^m still at *b*, and bright: it seemed now to be permanent at *b*; but clouds soon after spread over the sky, and shut out everything from sight.

These pulsations, in order to be seen, seem to require that the ecliptic should be at a high angle with the horizon; at which time the Stronger Light is very brilliant. Last evening about 7^h 20^m or 30^m, I overheard one of the quartermasters, as he was looking at it, remark to another: "If that was not in the wrong part of the sky, I should say that the sun was just going to rise there."


No III
50°

No. 112.

JANUARY 31st, 1854: Morning.

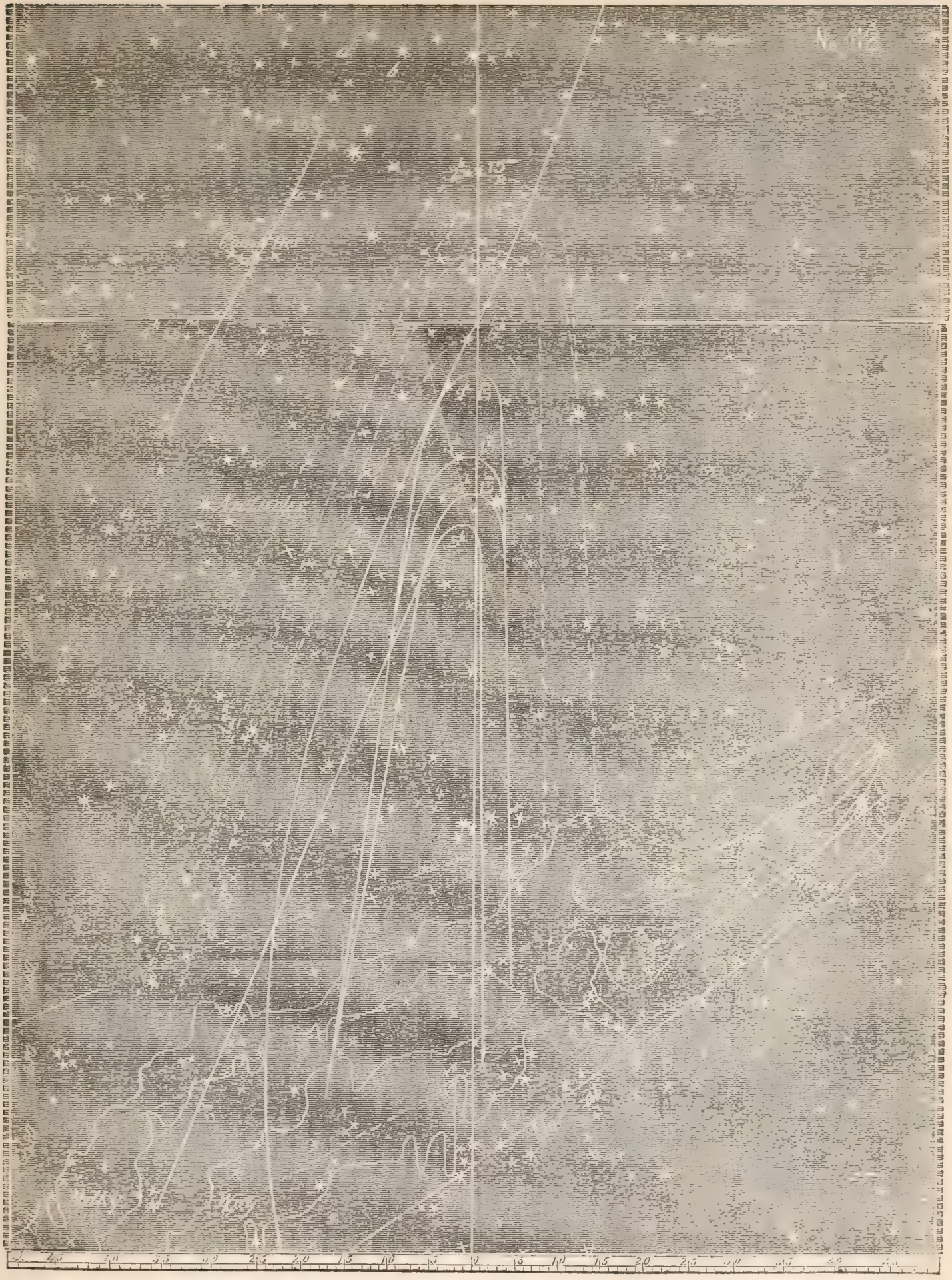
Lat. 26° 10′ N: Lon. 127° 42′ E.

Sun rose 6h 49m.

Stronger and Diffuse Light	2h 15m	to	3h 15m	Paled sky.
	3 15		4 15	
	4 15		5 0	
	5 0			

Sun's Lon. 311° 21′.

There were clouds intervening till 2h 15m; after which got observations as in the chart. At 2h 15m the Stronger Light was dim, but gave reliable boundaries. It is difficult to make out exactly the bounds of the Diffuse Light, on the left, on account of the paled sky beyond it on that side. The Stronger Light is now very dim, compared with what it was some time ago. No pulsations seen, though I watched attentively. At 5h, clouds on the right prevented my getting boundaries of the Diffuse Light. The limits of the paled sky are given in the chart, in dotted lines.

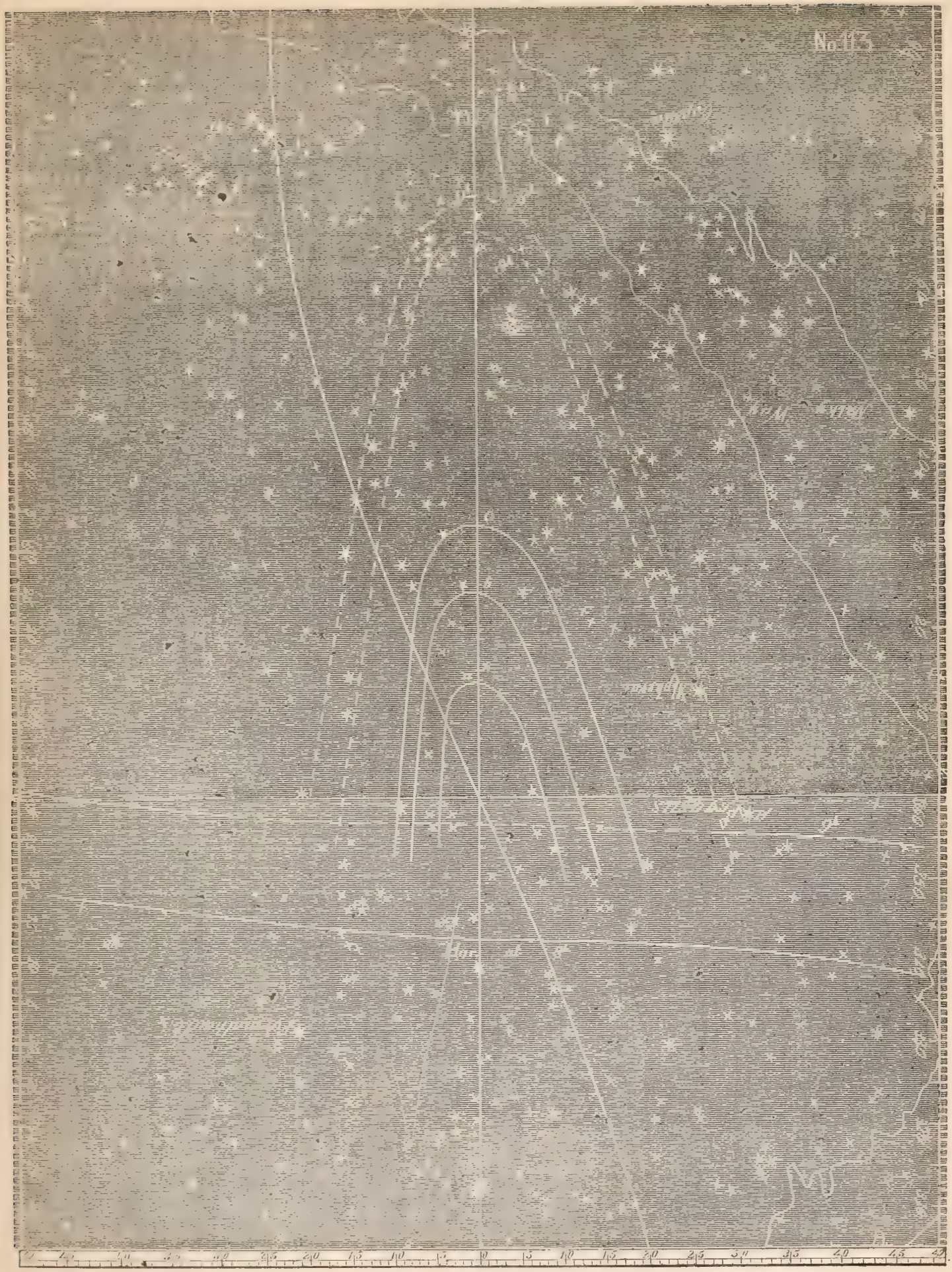

Arcturus

No. 113.

JANUARY 31st, 1854: Evening.

Lat. 26° 30′ N.: Lon. 127° 45′ E.
Sun set 5*h*. 38*m*.
Stronger Light 8*h*. &c.: Diffuse 8*h*. and 9*h*.

I was, at this time, on an exploratory tour over Loo Choo, but still made out to get good observations, and was particularly watchful about the pulsations of the Light. Moon set about 8 o'clock. For limits at 8^h and 9^h, see chart. The pulsations appeared, and were as follows: At $8^h\ 3^m$, the Stronger Light was at *a*, and dim; at $8^h\ 5^m$, at *b*, and bright; at $8^h\ 8^m$, at *a*, and dim; $8^h\ 12^m$, at *b*, and bright; $8^h\ 15^m$, at *a*, and dim; $8^h\ 19^m$, at *b*, and bright; and continued as at $8^h\ 19^m$ till $8^h\ 22^m$, when it began to ascend towards *c*, which it reached by $8^h\ 25^m$, and where it remained permanently. At 9^h it had this last (*c*) boundary, but had become considerably dimmed.

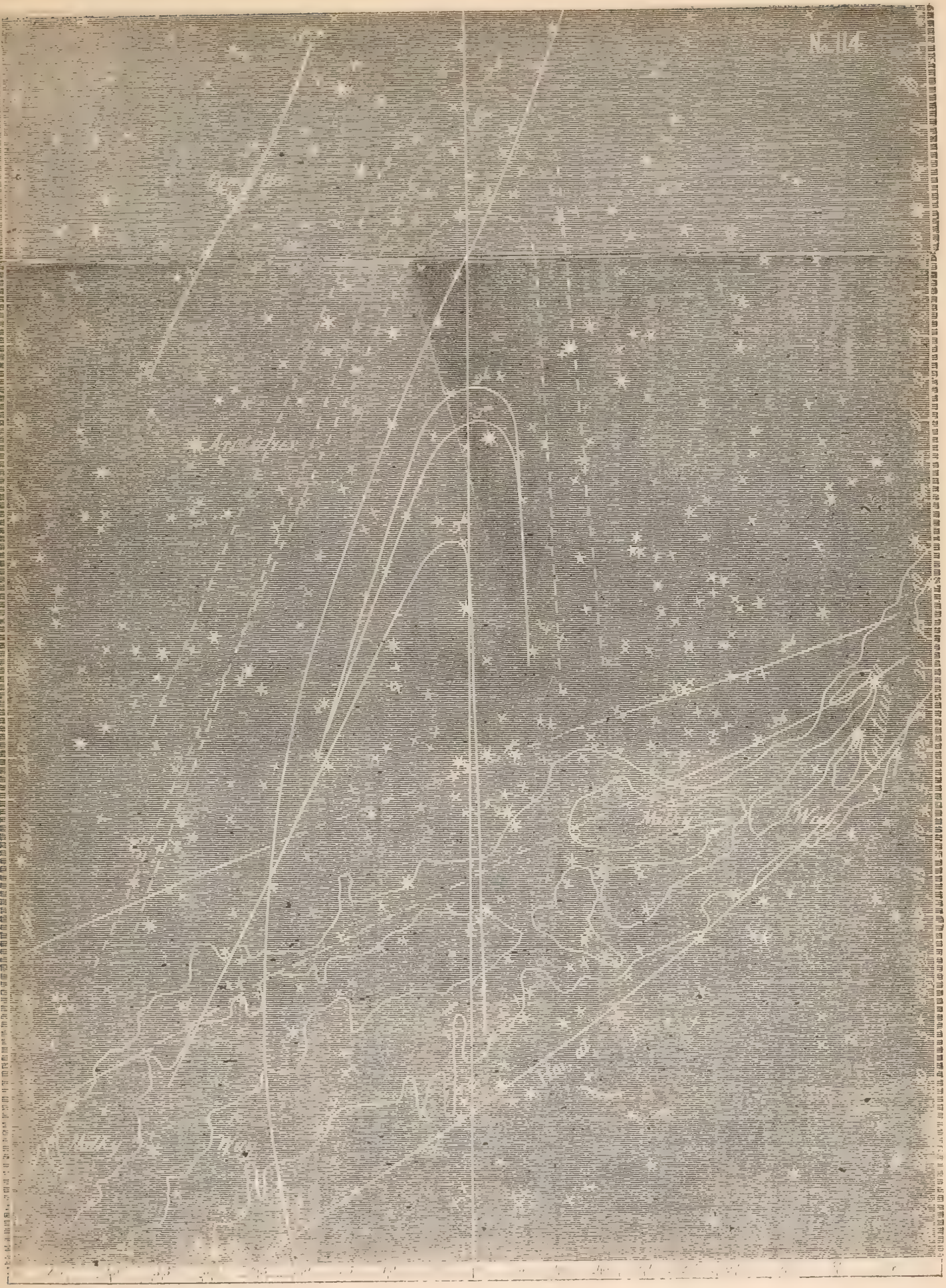

No. 13.

No. 114.

FEBRUARY 1st, 1854: Morning.

Lat. 26° 30′ N.: Lon. 127° 45′ E.
Sun rose 6*h*. 49*m*.
Stronger and Diffuse Light at 2, 3, and 5 o'clock.
Sun's Lon. 312° 22′.

The sky this morning was very good for observations; had one at 2 o'clock, at which time the Stronger Light, though dim, still gave reliable boundaries. At 3^h, it was brighter, though still dim, for it; at 5^h, also dim, comparatively. It had then slid considerably over to the left.

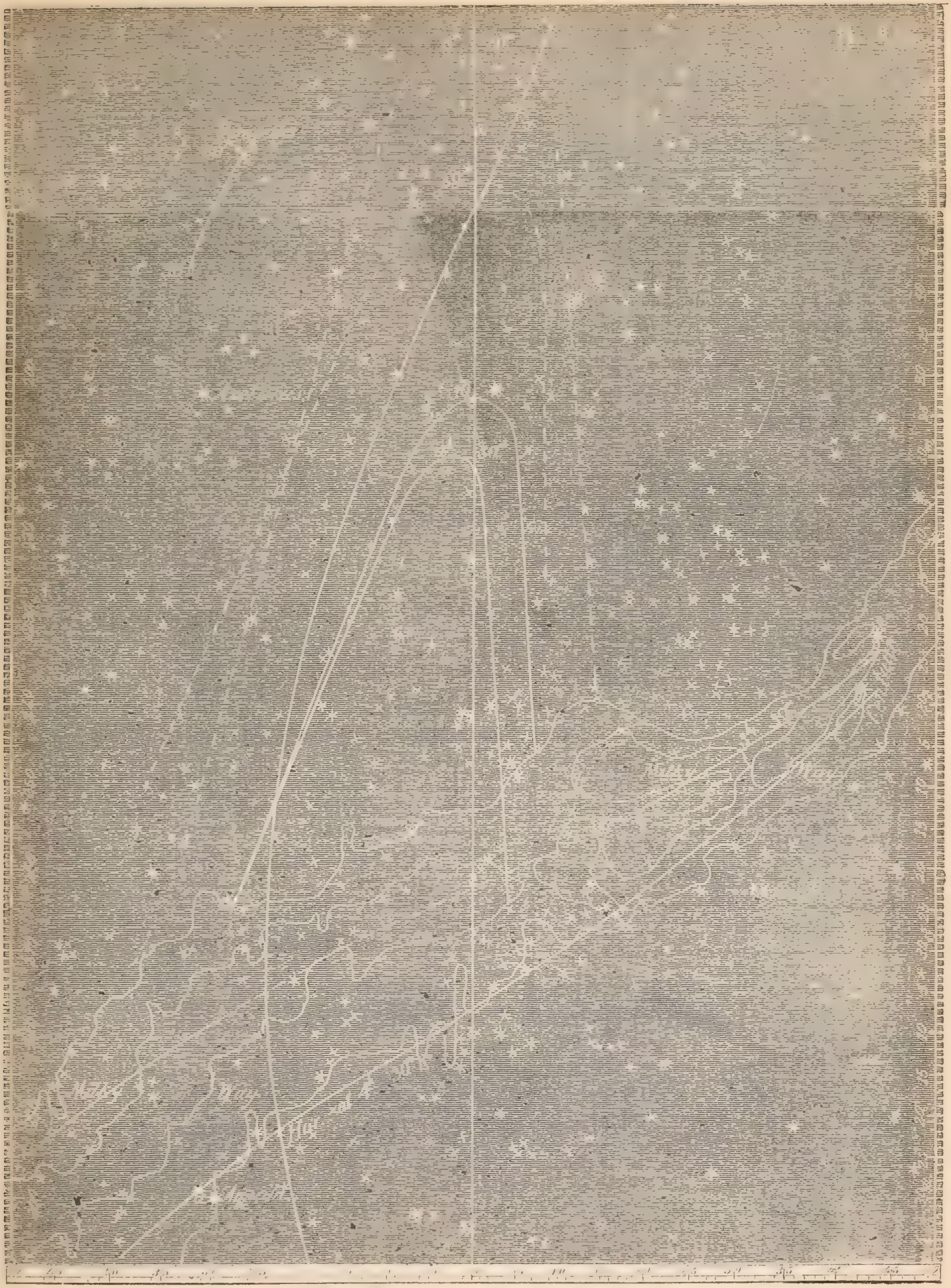

N. 14
Arcturus

No. 115

FEBRUARY 2d, 1854: MORNING

Lat. 26° 45′ N.: Lon. 127° 45′ E.
Sun rose 6*h*. 50*m*.
Stronger and Diffuse Light at 3*h*. 30*m*. and 4*h*. 30*m*.
Sun's Lon. 313° 23′.

Clouds last evening, and also this morning till $3^h\ 30^m$, when, and at $4^h\ 30^m$, I got observations. The sky was bright, but the Stronger Light, at $3^h\ 30^m$, was very dim, for it.

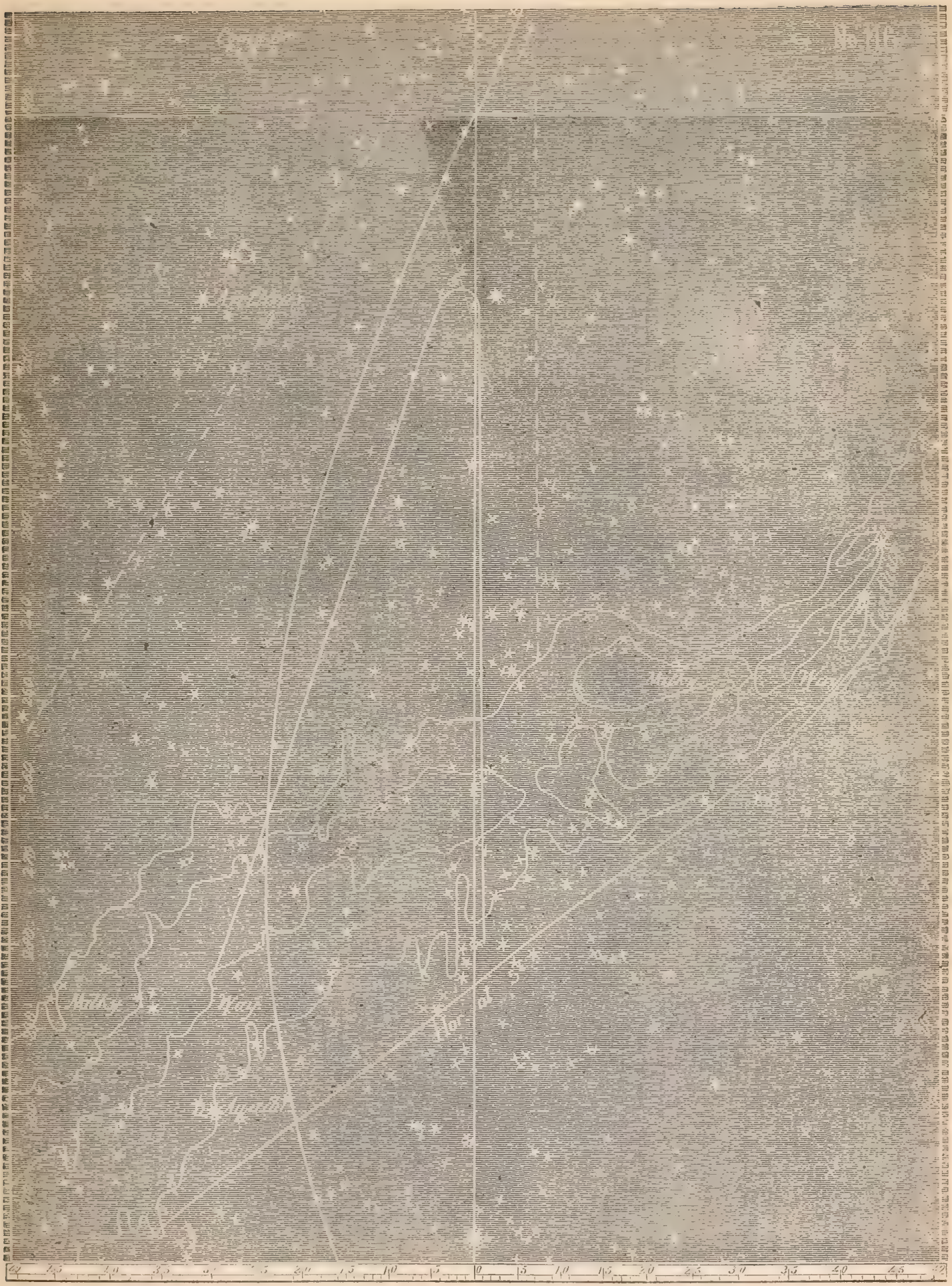


No. 116.

FEBRUARY 4th, 1854: Morning.

Lat. 26° 33′ N.: Lon. 127° 54′ E.
Sun rose 6*h*. 47*m*.
Stronger and Diffuse Light at 5 o'clock.

Clouds since last entry (2d) until 5^{h} this morning, when I got a good observation; for which see chart.


Milky Way
Milky Way
Milky Way

No. 117.

FEBRUARY 15th, 1854: Evening.

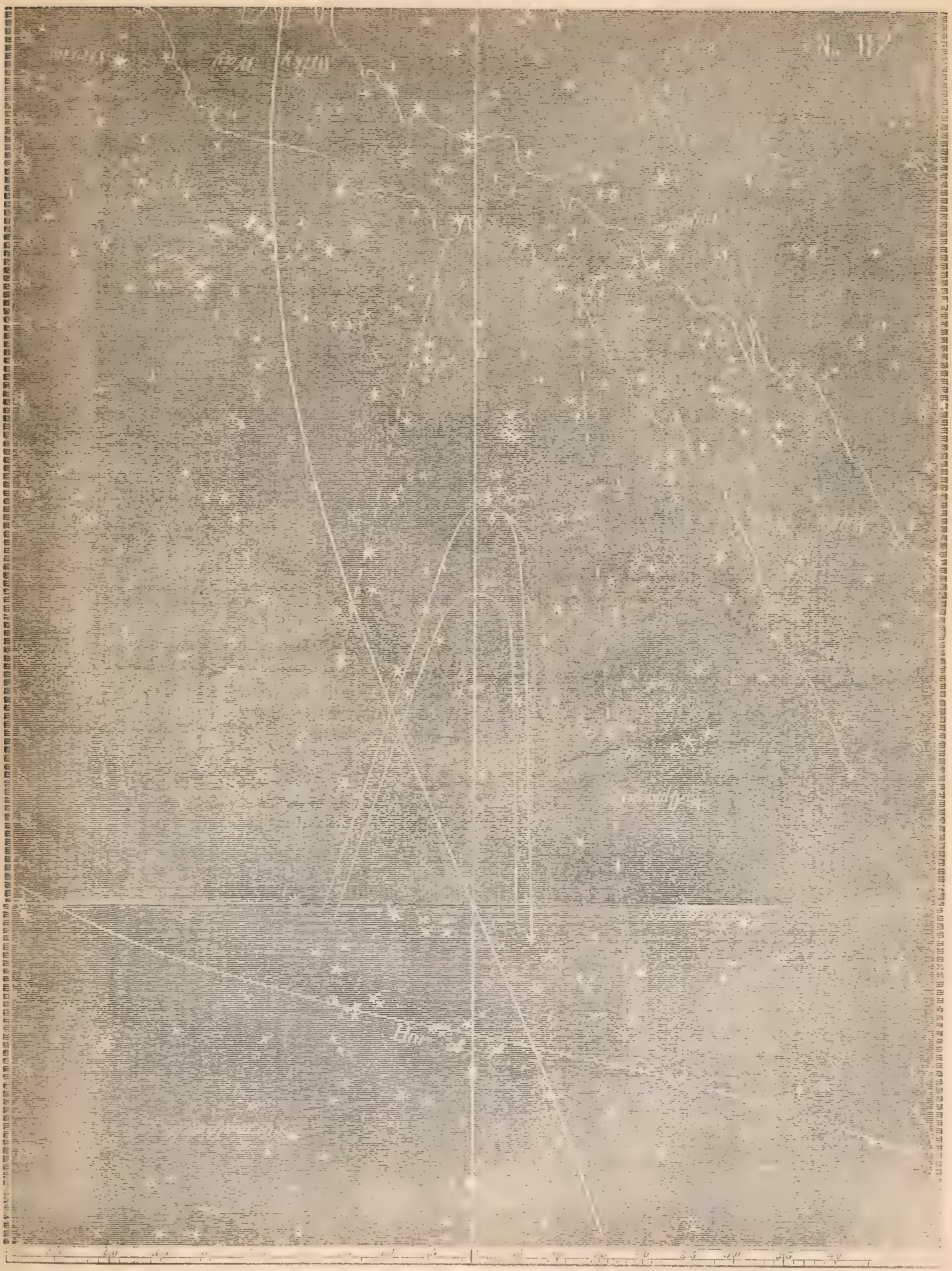
Lat. 35° 19′ N.: Lon. 139° 43′ E.

Sun set 5*h.* 38*m.*

Stronger Light { 7*h.* 0*m.* / 7 10 } Diffuse 7*h.*

This was a very fine evening; sky remarkably clear and good, except a streak of whiteness along the horizon, which, however, did not interfere materially with the Zodiacal Light. I watched for the first appearance of this Light. At 6^h 30^m, the western sky, above, was one uniform color; 6^h 45^m, the Zodiacal Light became dimly apparent—rather suddenly so—but no clearly definite bounds; 6^h 47^m, quite decided up to the Pleiades; could have got bounds, but preferred waiting till they should be more decidedly marked; 6^h 50^m, Stronger Light now showing itself, but no reliable boundaries to it; at 7^h, and at 7^h 10^m, got boundaries. At this time the Stronger Light was bright; had some suspicions of pulsations from *a* to *b* (see chart), but was not certain; could not watch with that care that such delicate observations require, as I was anxious to catch the first appearance of the moon's Zodiacal Light, now expected soon to appear; so I turned from the western to the eastern horizon.

Observation.—"There is a regular paleness of the sky from Regulus, up by Præsepe, &c., to the Milky Way, and about 8° wide; its centre nearly or quite on the ecliptic. It amounts almost, if not quite, to a positive light, and seems like a dim branch of the Milky Way, that has strayed off from the general course."—*My Notes.*



No. 118.

FEBRUARY 17th, 1874: Evening.

Lat. 35° 19′ N: Lon. 139° 43′ E.

Sun set 5*h*. 40*m*.

Stronger Light 7*h*. 0*m*. to 9 o'clock: Diffuse { 7*h*. 0*m*. / 7 30 / 8 0 / 9 0

Clouds and rain last evening. The early part of this evening was perfectly clear, and very fine for observations. Took boundaries at 7ʰ, and then watched to see whether there would be pulsations. Saw them, but they were not as distinct as at the last observations of this kind; yet, with close watching, they could be easily made out. They were confined to the Stronger Light, which, at 7 o'clock, was at *d*.

h. *m*.
At 7 3, at *c*.
7 7, at *d*.
7 10, at *b*.
7 12, at *d*.
7 14, at *a*, and very dim.
7 15, at *a*, and almost extinct.
7 17, at *b*, and brighter.
7 18½, has just reached *c*.
7 20, has just reached *d*.
7 21, has just reached *b*.
7 22½, still at *b*.

h. *m*.
At 7 24, at *c*.
7 25, at *d*.
7 26, has got up to *e*, but not brighter than when at *d*.
7 30, has got up to *f*.
7 35, still at *f*.
7 39, there seems to be a pulsating between *d* and *f*, and perhaps has been since 7ʰ 31ᵐ, but I cannot speak with certainty.
7 44, same as at 7 39ᵐ.
8 0, clearly no pulsations evident to the senses.

At 8ʰ and 9ʰ, the northern boundary of the Diffuse Light was difficult to be made out; it has now become so much more dim than formerly. I sometimes doubted whether I ought to put these boundaries down, they were so indefinite; but I have given them as, after careful consideration, they seemed to me to be.

No. 119.

FEBRUARY 18th, 1854: Evening.

Lat. 35° 19′ N.: Lon. 139° 43′ E.
Sun set 5*h*. 41*m*.

Stronger Light 7*h*., &c., to 9 o'clock: Diffuse { 7*h*. 0*m*. / 8 0 / 9 0

This was a beautiful evening; sky perfectly clear. Watched to see the Zodiacal Light make its first appearance. Sun set at $5^h\ 40^m$; sky had nothing unusual till, at $6^h\ 50^m$, I became, all at once, conscious that I was looking at the Zodiacal Light; but it was dim. Its boundaries then seemed to be as in *m* on the chart (probably an error occasioned by the usual horizontal whiteness); but the light was so dim that I could not fully rely on them. At $6^h\ 56^m$ it was quite decided. At 7^h the Stronger Light was at *d*. My attention was then called off for a few minutes, but. at $7^h\ 6^m$, it was at *d*, and so to $7^h\ 10^m$; all this while very bright. At $7^h\ 11^m$ it was dim; but at $7^h\ 12^m$ it had brightened again and dimmed, and it was now at *a*.

h. *m*.
At 7 13½, still at *a*.
7 14, at *c*, and bright.
7 15, at *b*, and dim.
7 19, still as at last.
7 20, at *a*, and as if dying away.
7 22, still as at last.
7 23, at *c*.
7 25, still as at last.
7 26, at *d*, and very bright.
7 27½, still as at last.
7 28, at *b*, and dim.
7 29, still at *b*, and as if dying away.
7 30, same.
7 31, at *d*, and very bright.
7 32½, still the same.
7 34, at *e*.
7 38, still at *e*, but not so bright as when at *d*. It seems to be pulsating still, but I cannot tell with certainty.

h. *m*.
At 7 40, the *brightness* pulsates, but I cannot perceive any pulsations in the *boundaries*.
7 42, at *e*. The light is dim for this altitude.
7 43, at *e*, brightened.
7 44, at *e*. It is dim for this altitude.
7 45, do. do. do.
7 48, still the same.
7 49, at *e*. Some little brightening up.
7 51, at *e*, has brightened so as to be as when formerly at *d*; so it remained.
8 0, it was at *f*, and there were no more apparent pulsations.
9 0, light steady. It has gradually dimmed since 8^h, but is still tolerably bright.
10 23, boundaries as at 9^h, and light faint.

No. 120.

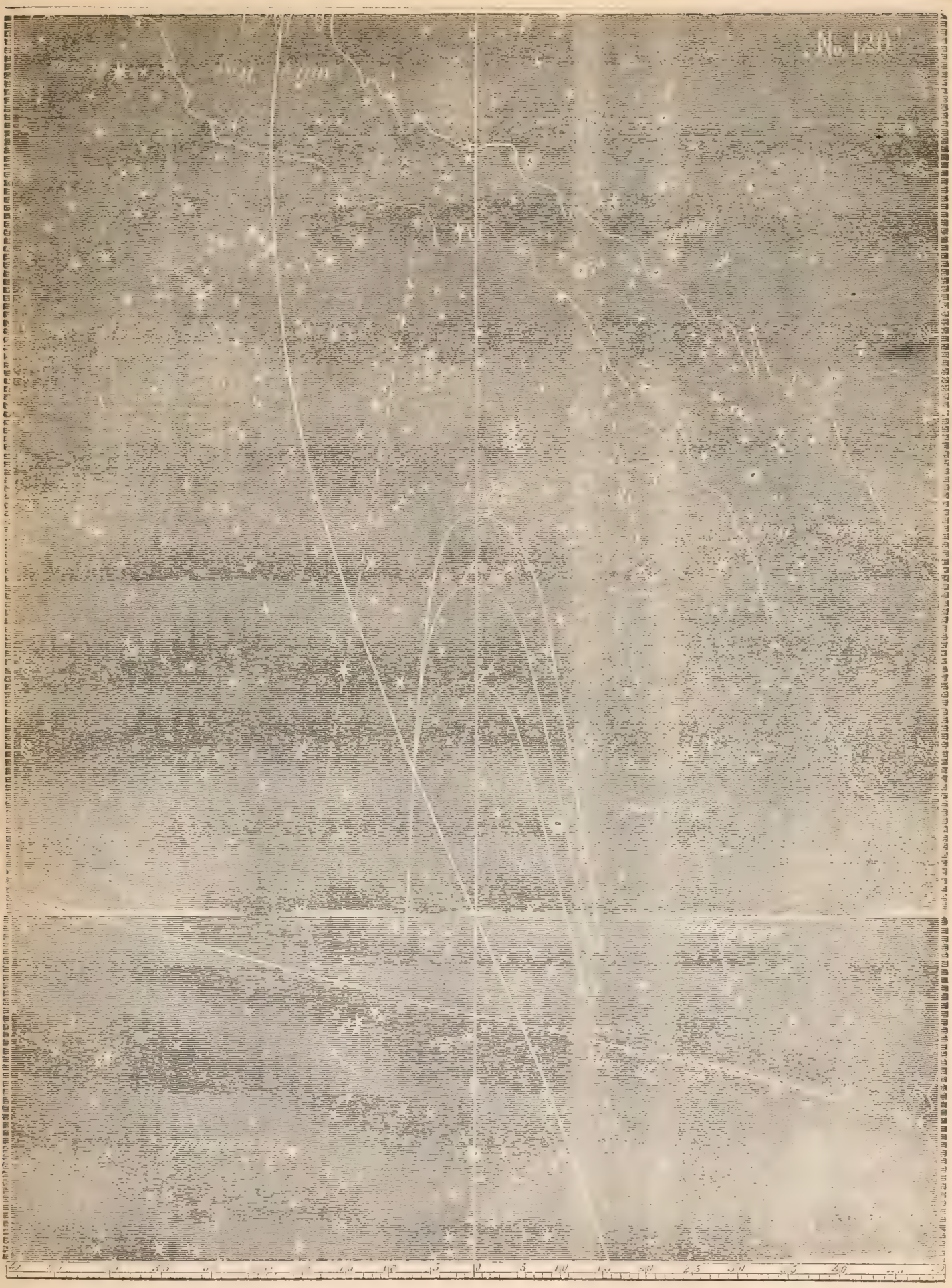
FEBRUARY 27th, 1854: EVENING.

Lat. 35° 19′ N.: Lon. 139° 45′ E.

Sun set 5*h* 42*m*.

Stronger Light { 7*h*. 0*m* / 7 10 / 7 16 } Diffuse at 7*h*.

Some clouds along the western horizon; but, at 7*h*, got boundaries as in the chart; the boundaries, however, not very distinct. Began soon after to observe pulsations; but as these require a good sky in order to be taken reliably, and the clouds broke the view, I soon gave up the effort. It was evident, however, that the pulsations were going on, both in the extent and in the brightness of the Zodiacal Stronger Light. At 7*h* 10*m* and 7*h* 16*m*, the Light was as in the chart. At 7*h* 16*m* it had just brightened and risen; but I could get nothing reliable below. At 8*h* the clouds had covered all the sky; and so they remained during the rest of the night.



No. 121.

FEBRUARY 21st, 1854: Evening.

Lat. 35° 19′ N.: Lon. 139° 43′ E.
Sun set 5^h $43\frac{1}{2}^m$.
Stronger Light 7^h. 15^m., &c., to 8^h.: Diffuse 7^h. 30^m.

Clouds and rain all day, and a gale blowing. Did not look for any thing in the evening; but all at once I found the stars out, and the sky perfectly clear. At 7^h 15^m I was ready to make a record of the sky. At that time the Stronger Light was at *a*.

h.	*m.*	
At 7	19,	it was at *c*.
7	20,	at *b*, and dying away.
7	21,	at *a*.
7	22,	do.*
7	23,	at *b*.
7	25,	at *d*.
7	26,	do.
7	27,	at *a*.
7	28,	at *d*.
7	30,	do. and has brightened till it is as if the sun was just going to rise.
7	31,	at *b*.
7	32,	do.
7	33,	at *d*.
7	34,	do.
7	35,	at *a*, and seems to be dying away.
7	36,	at *b*.
7	37,	at *d*.
7	38,	do.
7	40,	at *e*.
7	41,	do.
7	43,	do. but dim.
7	44,	do. and bright.
7	46,	do.
7	47,	do. and dim.
7	48,	at *f*, and bright.
7	51,	do. and bright. It seems to be permanent at *f*, and is quite bright; but not so bright at its lower part as when it was at *d*.
7	54,	still as at 7^h 51^m.
8	0,	it has risen to *g*, but no longer pulsates.

It was uniformly dim at the lower elevations, and bright at the higher; but the Light seemed generally to rise faster than it brightened.

Clouds crossed the sky soon after 8^h, and at 9^h I could get no observation.

* In all this record of pulsations, "do." means *still continued* as at the last.

No. 122.

FEBRUARY 23d, 1854: Evening.

Lat. 35° 19′ N.: Lon. 139° 43′ E.

Sun set 5*h*. 45½*m*.

Stronger Light, 7*h*. 8*m*., &c. to 8 30 } Diffuse, 7*h*. 10*m*. and 8*h*. 30*m*.

Clouds last evening. This evening blowing a gale, (thermometer 37°, and at 3 a. m. at 32° Fahrenheit,) but the sky beautifully clear, and very fine for observations. Had the pulsations of which I took account, as follows. The Stronger Light at $7^h\ 8^m$ was at *c*: $7^h\ 12^m$ still the same, and now bright:

h. *m*.

At 7 13, at *b*, and dim.
7 14, do. and very dim.
7 15, at *c*, and bright.
7 16, do. do.
7 16½, do. and strikingly bright.
7 17½, do. do. do.
7 18½, at *b*, and dim.
7 19, do. do.
7 20, at *c*, and bright.
7 22½, do. do.
7 23½, at *a*, and dying away.
7 25, brightening and rising.
7 26, at *c*, and bright.
7 26½, do. and very bright.
7 27, do. do.
7 27½, begins to be dimmed, and to descend.
7 28½, at *b*.
7 29½, at *a*, and dying away.
7 30, at *b*.
7 31¾, at *c*, and bright.
7 32½, do. do.
7 33, do. and very bright.

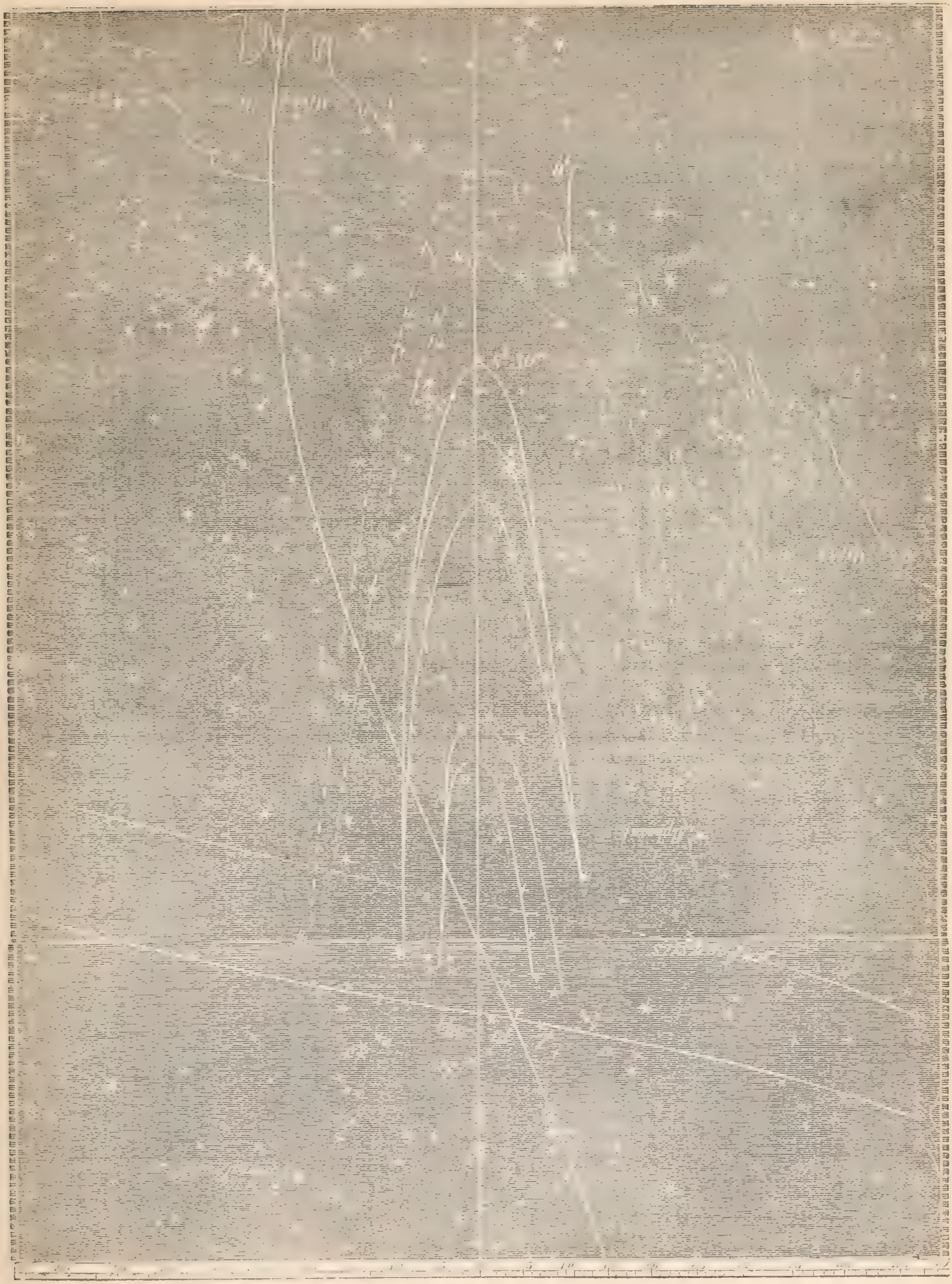
h. *m*.

At 7 34, at *c*, and very bright.
7 34½, dimming, and descending.
7 35, at *b*.
7 35½, at *a*, and dying away.
7 36½, at *b*.
7 37, at *c*, and tolerably bright.
7 38, do. do.
7 38½, at *c*, and very bright.
7 40, do. do.
7 41, do. and not so bright.
7 42, do. do.
7 42½, do. and tolerably bright.
7 44, do. do.
7 44½, at *d*, and quite bright.
7 46, do. do.
7 47½, do. and not bright.
7 49, do. and bright.
7 50; it seems to be permanent at *d*: there seem to be some pulsations in brightness; but it is difficult to make them out reliably.
8 30, permanent at the place marked in chart.

The Diffuse Light is very dim, and can scarcely be bounded reliably; but I give it as it appears to me.

I notice, as a general thing, that the Light, when it ascends, gets its full elevation a minute or so before it gets its full brightness.

Very severe work this evening. The gale, with sharp air from the snowy mountains west of us (Bay of Yedo, Japan), seemed to pierce through the whole system; and when the work was through, I found it impossible to get warm. Had an attack of pleurisy in consequence.

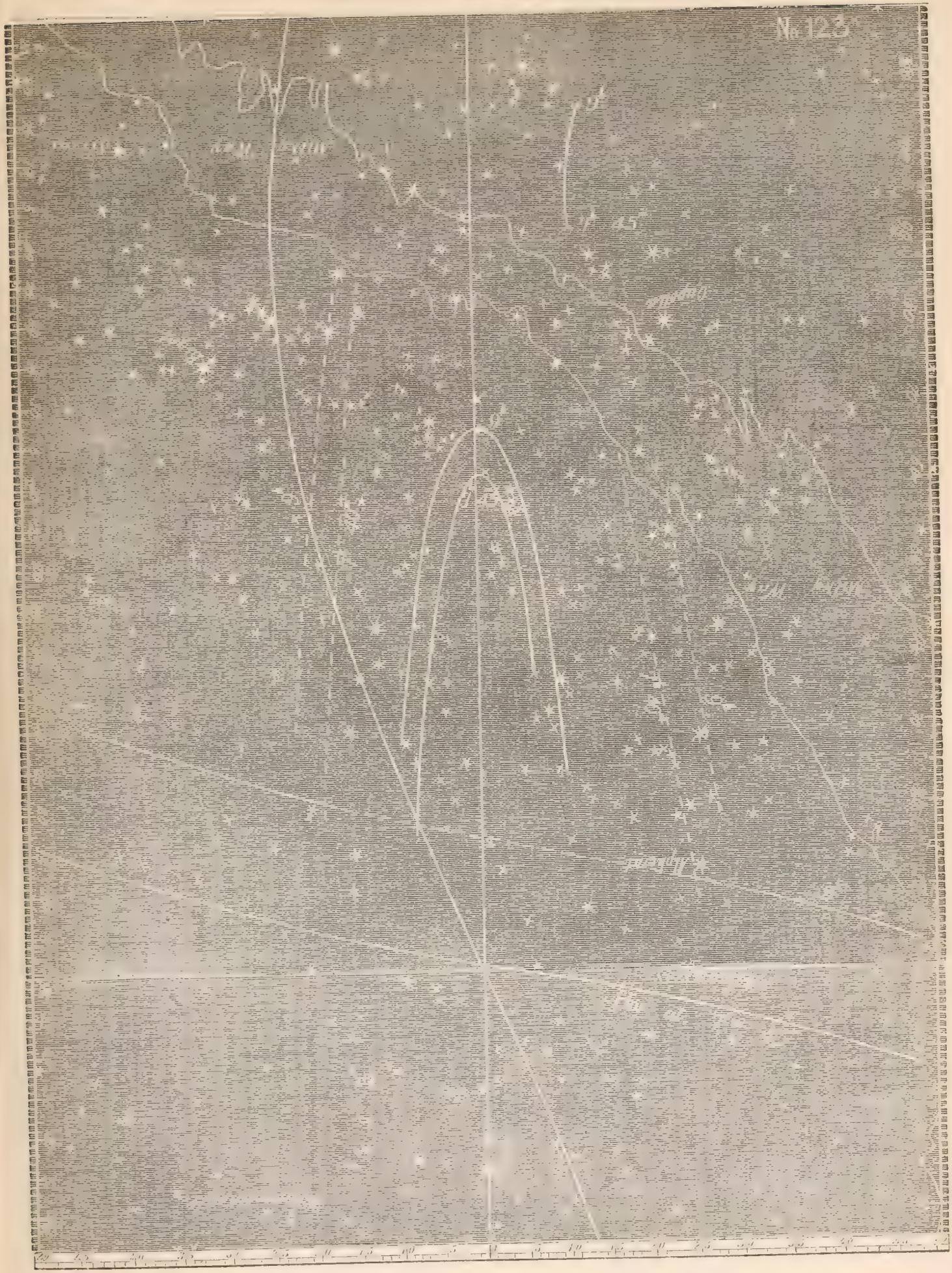


No. 123.

FEBRUARY 24th, 1854: Evening.

Lat. 35° 25′ N.: Lon. 13° 41′ E.
Sun set 5*h.* 46*m.*
Stronger and Diffuse Light, 7*h.* 45*m.* and 9*h.*

Clouds till $7^h\ 45^m$, when I got an observation: some clouds below prevented observations for pulsations. At 9^h the Stronger Light had faded considerably: clouds after that. (On the morning of the 24th, I went on deck at 3 o'clock, but although I could see that there was a Zodiacal Light, I could not get its boundaries; it was so faint, and its limits so indistinct. The ecliptic is now, in this latitude, very much inclined to the horizon. Was on deck also at 4^h, but with a similar result; saw the Light, which was stronger than at 3^h, but with no reliable boundaries. The difficulty is increased by the fact that the widest part of the Milky Way now crosses the Light just above the horizon. At 5^h went to try it again, but the moon was up; so did not succeed.)


No. 123

No. 124.

FEBRUARY 25th, 1854: EVENING.

Lat. 35° 25′ N.: Lon. 139° 41′ E.

Sun set 5*h*. 47½ *m*

Stronger Light 7*h*. 14*m*., &c., to 10*h*. 30*m*.: Diffuse { 7*h* 15*m*. / 8 0 / 9 0 / 10 0

Sun's longitude 336° 36′.

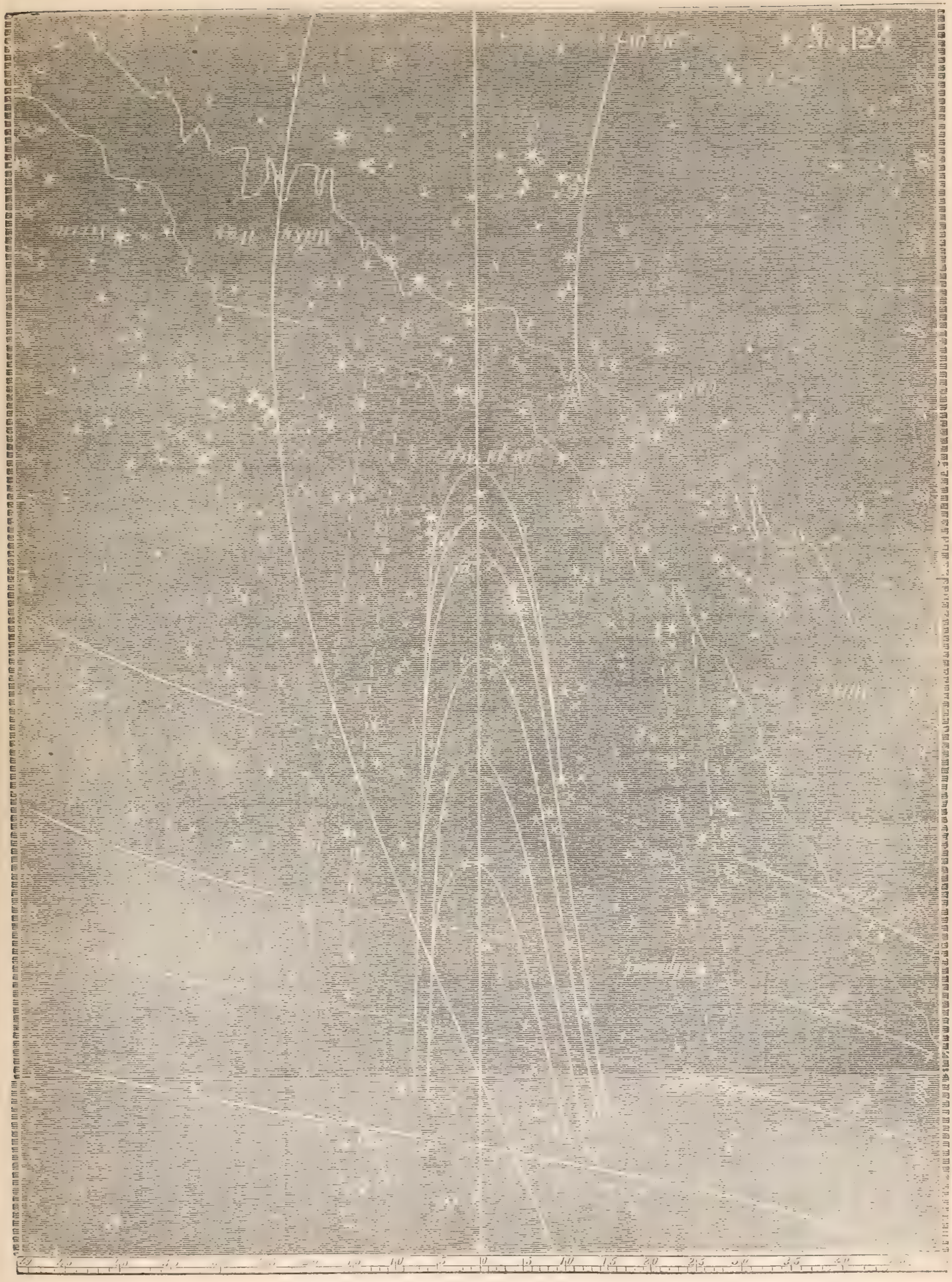
Clouds this morning. The evening sky was perfectly clear and very favorable, and I had good observations. At 7 o'clock the Zodiacal Light was visible, but not distinct enough for good outlines; 7ʰ 14ᵐ, took outlines as at *d*. (There seemed to be some slight pulsations from this to 7ʰ 19ᵐ, but could not make them out reliably.)

h. *m*.
At 7 19, dimming.
7 20, at *c*.
7 22, at *d*.
7 23, do.
7 24, at *c*.
7 25, at *a*.
7 26, ascending and brightening.
7 26½, at *c*.
7 27, at *d*.
7 28¾, at *a*, dying away.
7 30, at *d*.
7 30½, do. and brighter.
7 31½, same as last.
7 32¼, do. and very bright.
7 33, and 7ʰ 34ᵐ, same as last.

h. *m*.
At 7 35, dimming.
7 35⅓, at *c*.
7 36, at *b*, and dim.
7 37, do.
7 37½, brightening.
7 38, at *d*.
7 39, do. and brighter.
7 39½, do. and quite bright.
7 40, do. and not so bright.
7 41, do. and brightened again.
7 41¾, do. quite bright.
7 47, has continued so, and seems now to be permanent.
7 50, pulsations are now clearly over.

When ascending, the Light always gained its highest altitude before getting its greatest brightness at that altitude.

When this Stronger Light is going to be permanent, the *brighter* portion of it (before, below the spot marked *a*) now shoots up higher, as far as to *b*; 7ʰ 54ᵐ, has got up to *e*; 9ʰ and 10ʰ, was as in the chart. At 9ʰ 30ᵐ, the Stronger Light had dimmed some, but was still bright; at 10ʰ, boundaries as at 9ʰ 30ᵐ: Light dim, but easily made out; 10ʰ 30ᵐ, same as last; 10ʰ 30ᵐ, it is *sinking* down under the horizon—not dying away. At this hour its upper limit was near some haze on the horizon, and I gave up observing.

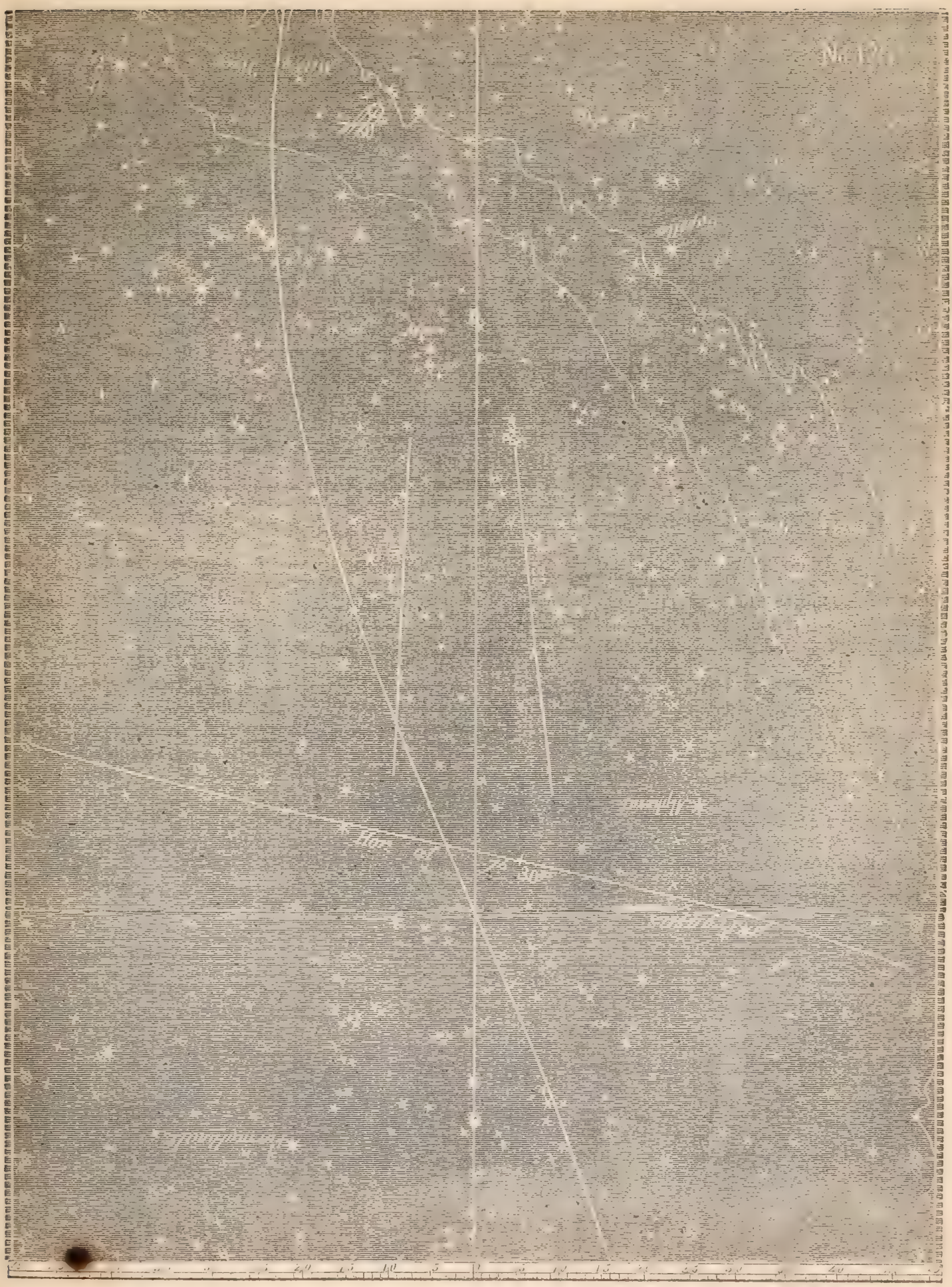


No. 125.

MARCH 6th, 1854: 7*h.* 30*m.*, p. m.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun set 5*h.* 54½*m.*

Joint Moon and Sun Zodiacal.—Clouds uniformly since last entry (February 25th). The moon quartered to-day, and I was not expecting anything this evening; but, on going on deck, at half-past 7, and looking up, I was astonished to see the Zodiacal Light fully displayed. It was, no doubt, *a joint sun and moon Zodiacal Light*, the moon happening, just at that time, to be in a position in which, instead of preventing the sun's Zodiacal Light from being seen by its own effulgence, it made an additional light, which was sufficient to show itself, even amid the strong general moonlight. Though this Zodiacal Light was quite distinct, yet, to add to my certainty, I called two of the quartermasters, separately, and asked them if they saw any peculiar light in the western quarter of the sky. They (each) saw it at once; and, on my asking them to give its boundaries, the first bounded it as in the chart, which agreed with my own judgment. The other gave it a wider space, but said that its brighter part was, as I have described, within the limits which I have given it. My own mind was perfectly satisfied that it was clearly a Zodiacal Light. It differed from the ordinary sun or moon Zodiacal Light, in not being brightest at its lowest end, but was, all the way down, of a pretty uniform brightness. It was quite distinct. The upper end was lost in the moon's superior light. The night was then very clear. When I came up again, at 8ʰ 30ᵐ, the sky was rather hazy, and nothing of this could be made out.

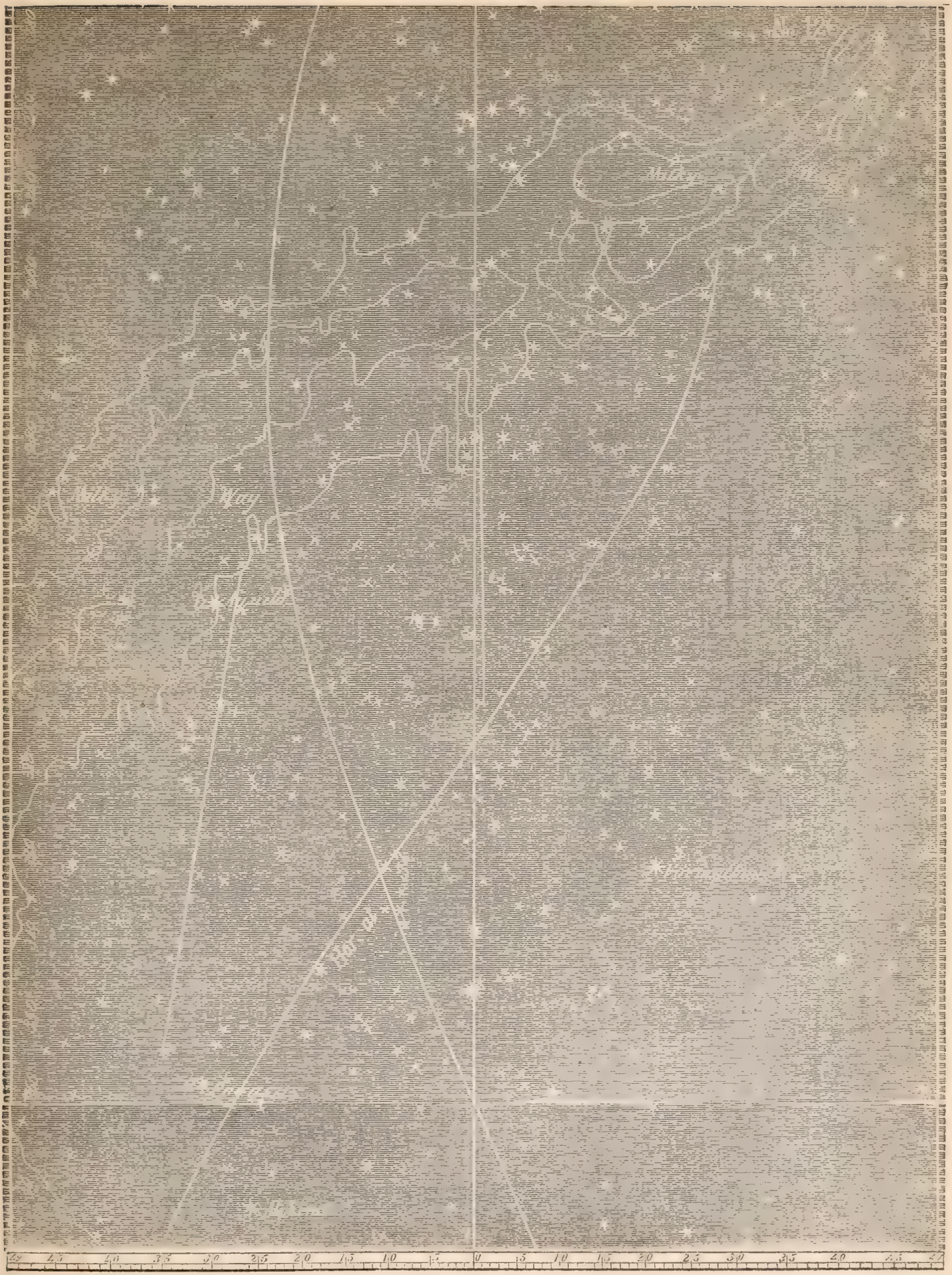


No. 126.

MARCH 7th, 1854: Morning.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun rose $6^h.\ 25\frac{1}{2}^m$.
Stronger Light at 5 o'clock.

Clouds have prevented all morning observations since the unsuccessful effort of February 24th; but this morning was a very clear one, and I made another attempt at 5 o'clock. The ecliptic now, in this high latitude, makes a low angle with the horizon; and, above the Milky Way, there was decidedly no Zodiacal Light to be seen; but, below the Milky Way, it was very strong, and there could be no doubt about it. I have given its boundaries in the chart, its upper end being lost in the Milky Way. What I saw was the Stronger Light. This Light was so strong as evidently to cheat the officer of the deck in the flag-ship (Powhatan), and to make him believe it was dawn long before it was really so. Some time after 5^h the Light began to show a stronger spot towards the left, which, ascending there, soon became dawn.


4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 .5
0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

No. 127.

MARCH 18th, 1854: Evening.

Lat. 35° 2′ N.: Lon. 139° 42′ E.
Sun set 6*h*. 5*m*.
Stronger and Diffuse Light at 7*h*. 40*m*. and 9*h*.

Clouds since the last date till this evening; then clouds, also, till 7ʰ 40ᵐ, when, and at 9ʰ, I got observations as in the chart; thought there were pulsations at 7ʰ 40ᵐ, &c., but some remains of clouds towards the horizon made this not certain. The Stronger Light was quite distinct till the moon rose, at 9ʰ 57ᵐ.

No. 128.

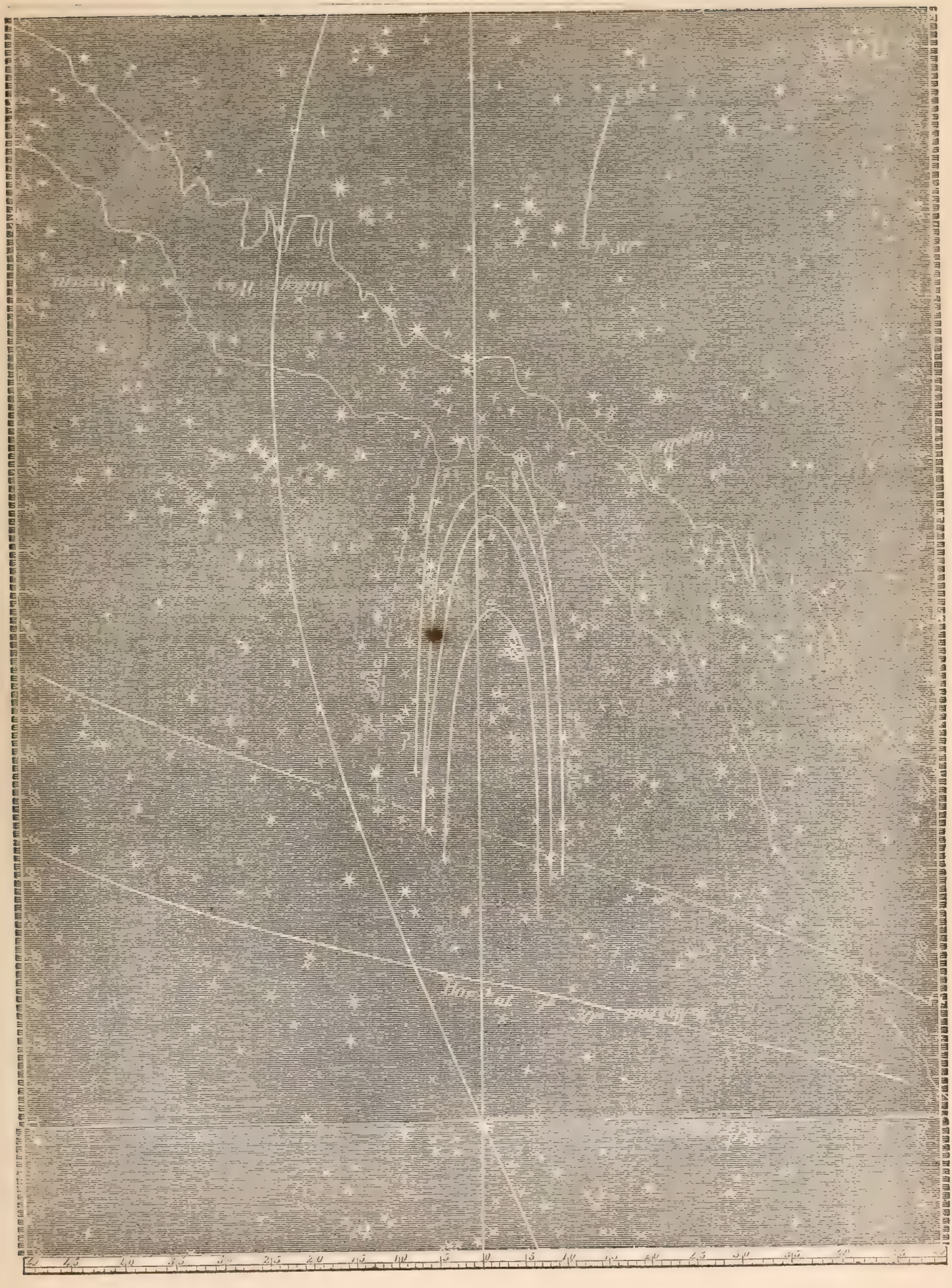
MARCH 20th, 1854: Evening.—(Monday.)

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun set 6*h* 7½*m*.
Stronger Light 7*h*. 30*m*., &c., to 9*h*.: Diffuse 7*h*. 30*m*. to 9*h*.

This was a fine evening for observations, and I was very watchful to see whether there would be pulsations or not. Sun set at $6^h\ 7\frac{1}{2}^m$. At $7^h\ 14^m$, the Zodiacal Light was visible, but gave no perfectly reliable boundaries. At $7^h\ 30^m$, got them both for Diffuse and Stronger Light; the latter was then at *b*.

h. *m*.	
At 7	33½, at *b*, and bright.
7	35½, at *a*, and dim.
7	36¼, at *b*, and bright.
7	38½, still do.
7	39, at *a*, and dim.
7	40½, do. do.
7	41½, at *b*, and bright.
7	44, do. do.
7	46, at *a*, and dim.
7	47, dim.
7	47½, brightening.
At 7	48½, at *b*, and bright.
7	50, do. and quite bright.
7	52, at *c*, do. do.
7	55½, do. and very bright—brighter than at any time before, this evening.
8	0, as at last, and seems to be permanent.
8	2½, to *b*, and seems to be pulsating; but this is very uncertain.
8	8, seems to be permanent.
8	12, same as last.

At 9 [10?] o'clock, could see the Light very well to the Pleiades, but could not get its boundaries beyond that, reliably. These pulsations are not as striking as a month ago, and sometimes are difficult to be made out. The Stronger Light not so strong as formerly.



No. 129.

MARCH 25th, 1854: Evening.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun set 6*h.* 11*m.*
Stronger Light 7*h.* 30*m.*, &c., to 9*h* 30*m.*: Diffuse 7*h.* 45*m.*

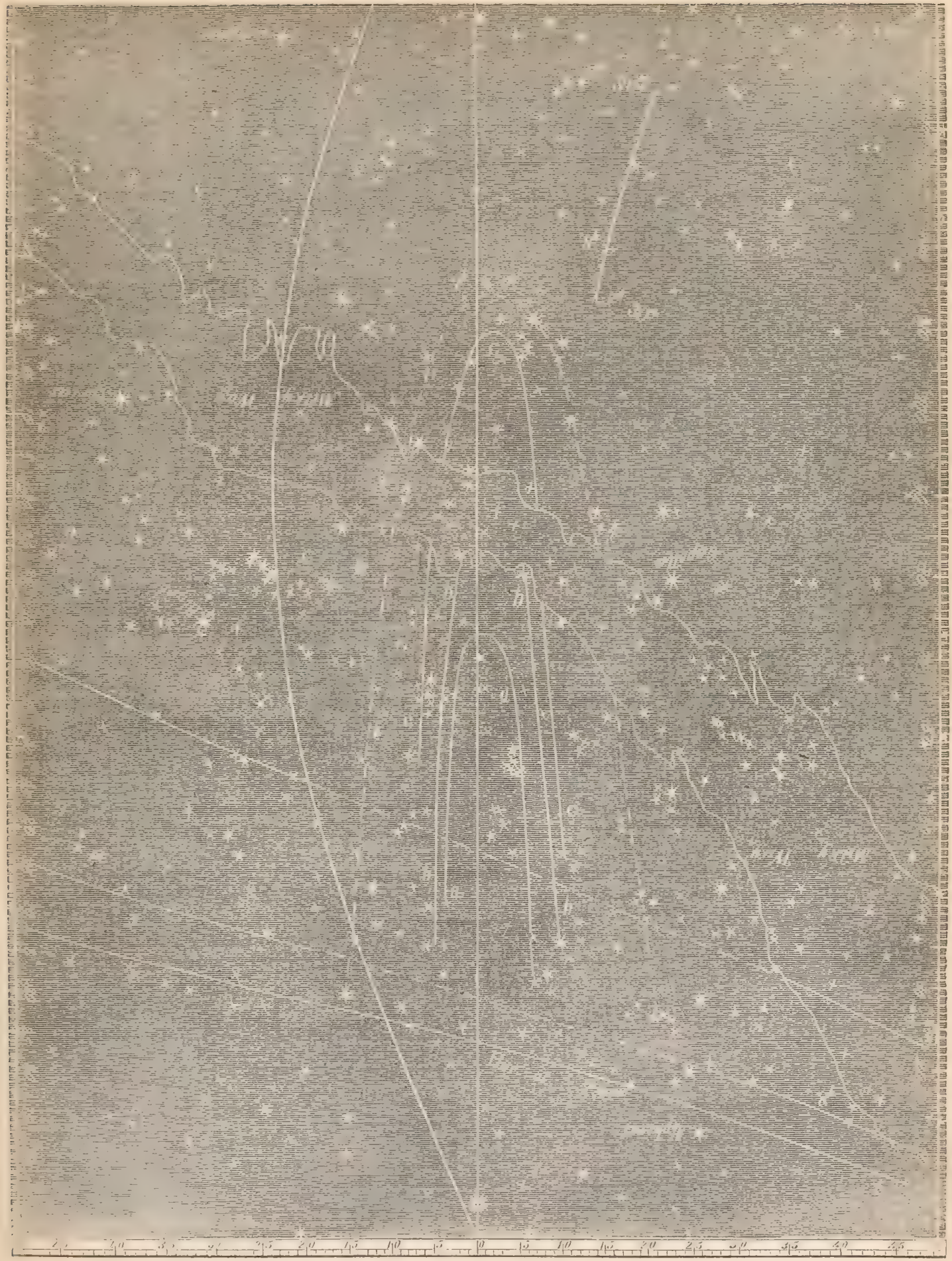
Clouds since last, till this evening, which was very clear. Watched for the first appearance of the Zodiacal Light. Sun sets at $6^h\ 11^m$ At $7^h\ 10^m$ no sign of Zodiacal Light yet; Milky Way also not yet distinguishable: $7^h\ 25^m$, now, for the first time, the Light decidedly showing itself, as also the Milky Way; does not yet give reliable boundaries. $7^h\ 24^m$, could now get boundaries at the lower, but not at the upper end; $7^h\ 30^m$, got boundaries of Stronger Light, and at $7^h\ 45^m$ of the Diffuse. At $7^h\ 35^m$ Stronger Light was at *b*, and bright; its upper end seemed to extend into the Milky Way; but of this I could not be certain.

h. m.
At 7 37, still at *b*, and bright.
7 39, at *a*, and dim.
7 40, do. and quite dim.
7 40½, brightening.
* * * (Changes apparently, but could not be certain of them.)
7 43½, at *a*, and now dim.
7 46, at *b*, and bright.
7 47½, do. do.

h. m.
At 7 50½, at *b*, and very bright.
8 0, the upper end of the Stronger Light now *clearly* extends into the Milky Way; perhaps a little beyond it.
8 5, Stronger Light now brighter than at any time previously this evening.
8 22, still very bright. After this, it seemed to dim a little.

Sometimes these changes seemed to be very evident, sometimes so dubious that I felt reluctant to record them. I give the notes, however, as they were made at the time.

At $9^h\ 30^m$, the Stronger Light was evidently above the Milky Way; its outlines are in the chart, marked *c c*. At $10^h\ 20^m$ the Stronger Light still visible, but so indefinite that I cannot bound it.



No. 130.

MARCH 27th, 1854: MORNING.

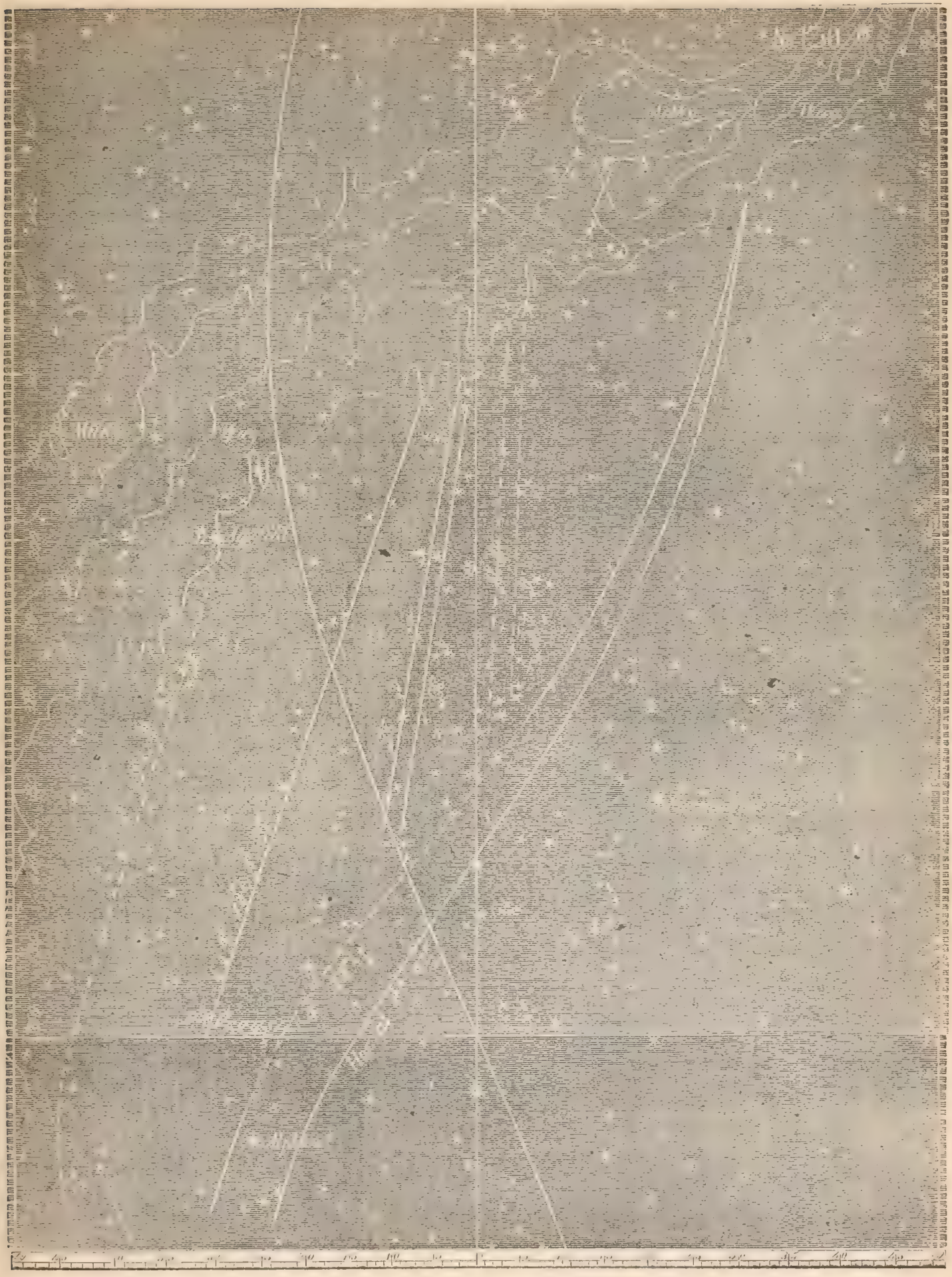
Lat. 35° 26′ N.: Lon. 137° 42′ E.

Sun rose 5*h.* 58½*m.*

Stronger Light { 4*h.* 22*m.* / 4 30 / 4 40 } Diffuse 4*h.* 22*m.*, 4*h.* 43*m.*

Zenith Point at 4*h.* 45*m.*: Lat. 58° 20 N.: Lon. 248° 0′.

(26th was Sunday.) Was called at 4 o'clock, and had an extremely interesting observation. The peculiar interest arose from the fact of the obliquity of the ecliptic with the horizon. (The angle was 31° 9′.) Yet the Zodiacal Light, which was perfectly distinct, went stretching along the ecliptic, so that a line along its central part would make an angle of about 77° with a line perpendicular to the horizon. The boundaries are given in the chart. It will be seen that the right-hand or southern boundary of both Diffuse and Stronger Light shifted to the right as morning advanced and the horizon receded from it. Dawn at 4ʰ 39ᵐ.



No. 131.

MARCH 27th, 1854: Evening.

Lat. 35° 26′ N.: Lon. 139° 42′ E.

Sun set 6*h* 12½*m*.

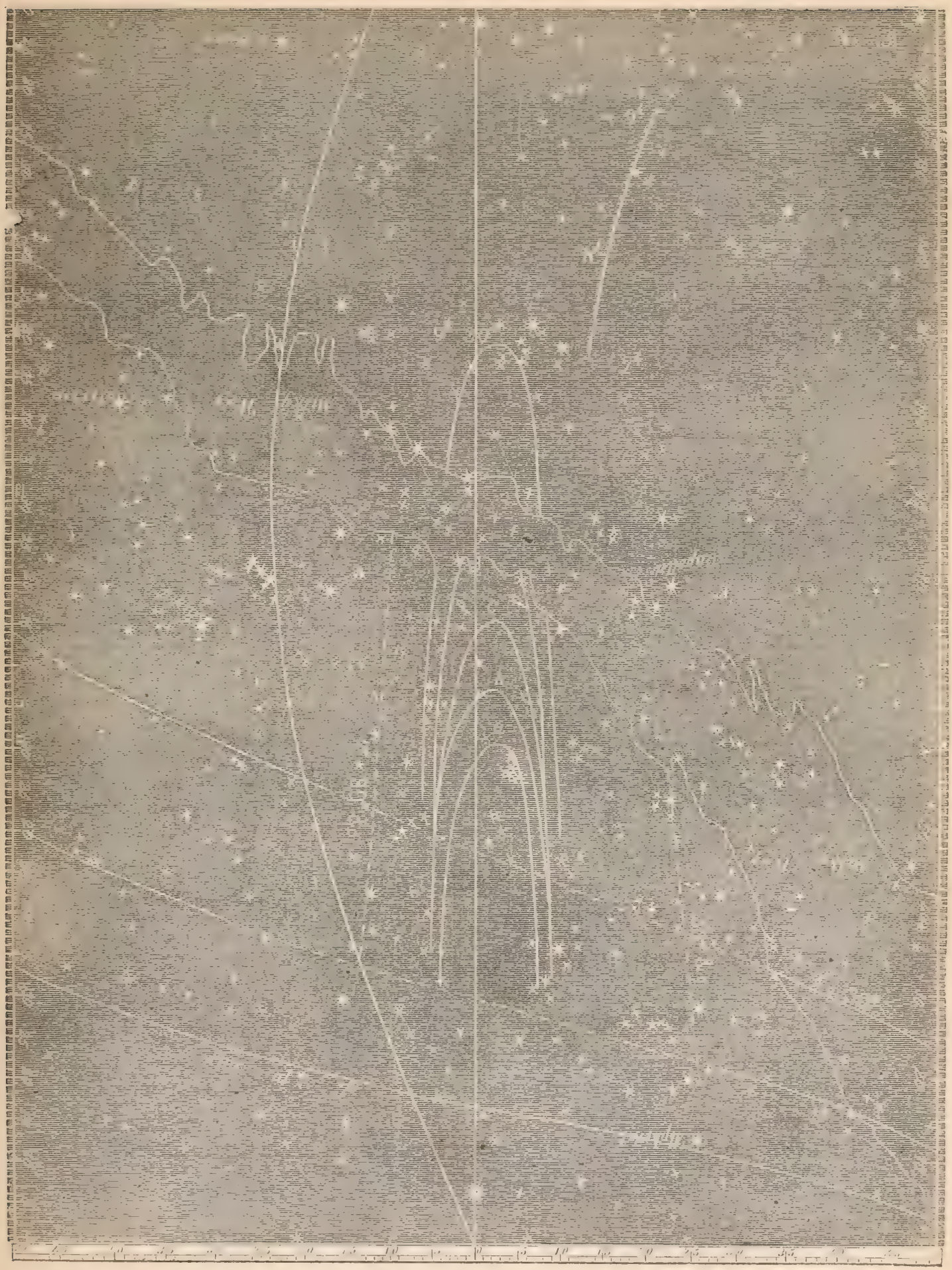
Stronger Light { 7*h*. 30*m*. / 9 30 } Diffuse at 7*h*. 30*m*., &c.

Sky remarkably clear. The following are my notes:—7ʰ 15ᵐ, a whiteness running up with the Zodiacal Light boundaries as far as the Pleiades, but its limits are not distinct: 7ʰ 24ᵐ, the light more decided, but its boundaries not reliable: 7ʰ 30ᵐ, got boundaries of both Diffuse and Stronger Light—the latter, then, strong up to *b*, and gradually tapering, dimming off to *c*.

h. *m*.	*h*. *m*.
At 7 35, at *a*, and dim.	At 7 54½, at *b*, and bright.
7 38, do. do.	7 55½, at *b*, and quite bright.
7 39, at *b*, and bright.	7 57¼, at *a*, and quite dim, as if dying away.
7 43, do. do.	7 58¼ do. do. do.
7 44, at *a*, and certainly dimmed.	7 58¾, brightening.
7 45, at *b*, and bright.	7 59½, at *b*, and bright.
7 47, at *a*, and dim.	8 0, do. and quite bright.
7 48½, do. do.	8 3, brighter than at any time yet, and has clearly ascended to the Milky Way by lines *d d*.
7 49, brightening.	8 4½, dimmed, and sunk to *b*.
7 50, at *b*, and bright.	8 7, brightening.
7 51, at *b*, and quite bright.	8 8, very bright, and at *d d*.
7 52¼, dimming.	8 15, still as at last, and seems to be permanent now.
7 52½, at *a*, and dim.	9 30, boundaries to *x*.
7 53½, brightening.	

I think I can know when it is going to be permanent, by the upper portion of the Light brightening more than at any time previously in the evening, and the strong brightness ascending higher up. The first appearance of the Zodiacal Light seems to be a white light —*i. e.*, when the twilight is not fully gone; afterwards it changes to a warm yellowish light. The reverse of this happens in the morning. The Diffuse Light is now very dim: in the morning it is very strong, for it.

This evening was remarkably fine for observations, and in my notes is the remark: "It *certainly* does pulsate."

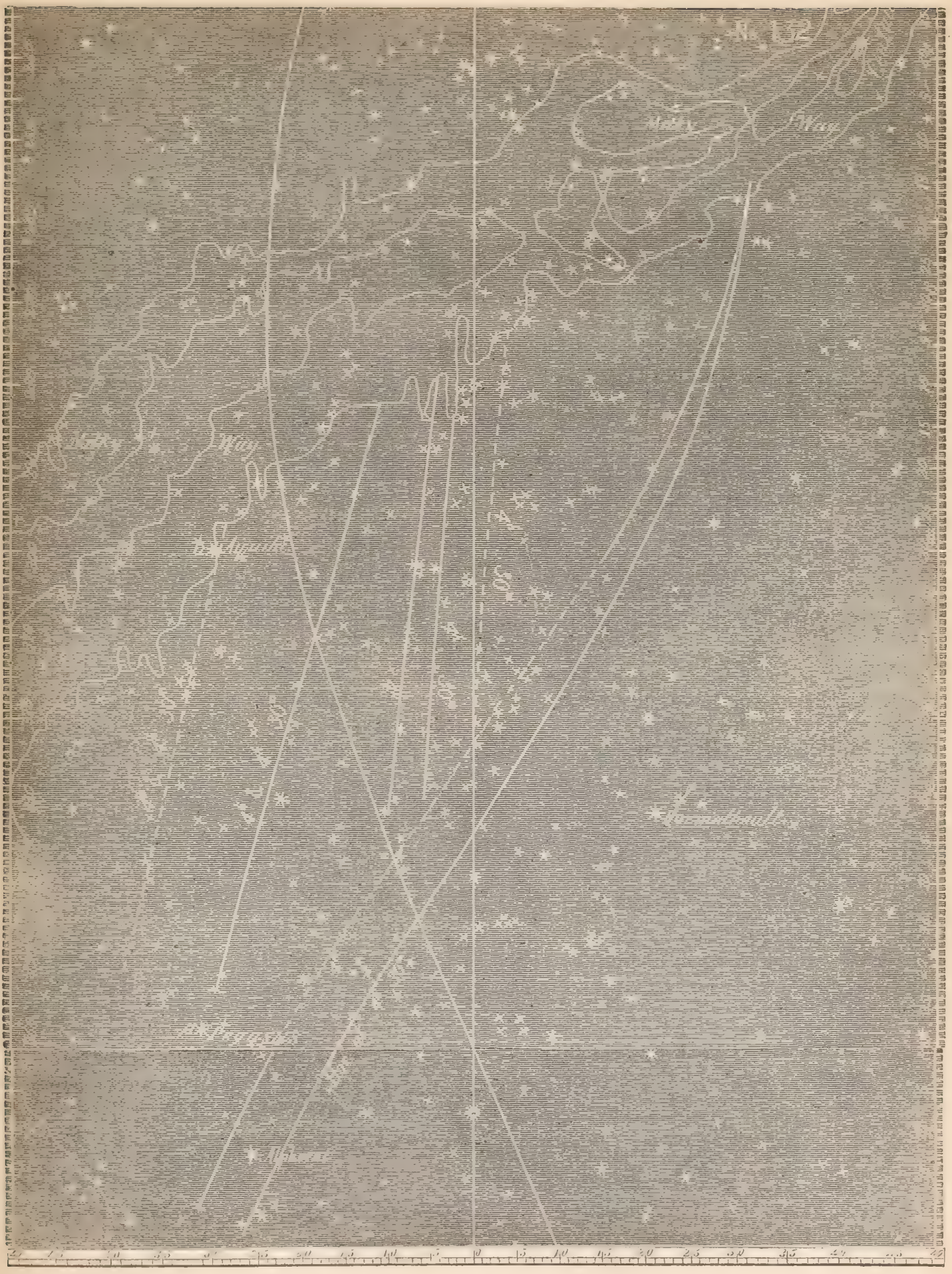


No. 132.

MARCH 28th, 1854: Morning.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun rose 5*h*. 5*m*.
Stronger and Diffuse Light at 4*h* and 4*h*. 30*m*.
Zenith at 4*h*. 30*m*., Lat. 57° N.: Lon. 245°.

Was on deck at 4 o'clock. Previous to that, the Milky Way is too near the horizon for any valuable observations. At 4^h, could not get the lower or southern boundary of the Diffuse Light, on account of its propinquity to the horizon. The morning was unusually clear, but could see no Zodiacal Light above the Milky Way. The Diffuse Light, especially on the left, or north, is now so strong that it is rather difficult to say where the boundary-line between it and the Stronger is. Dawn about 4^h 43^m.

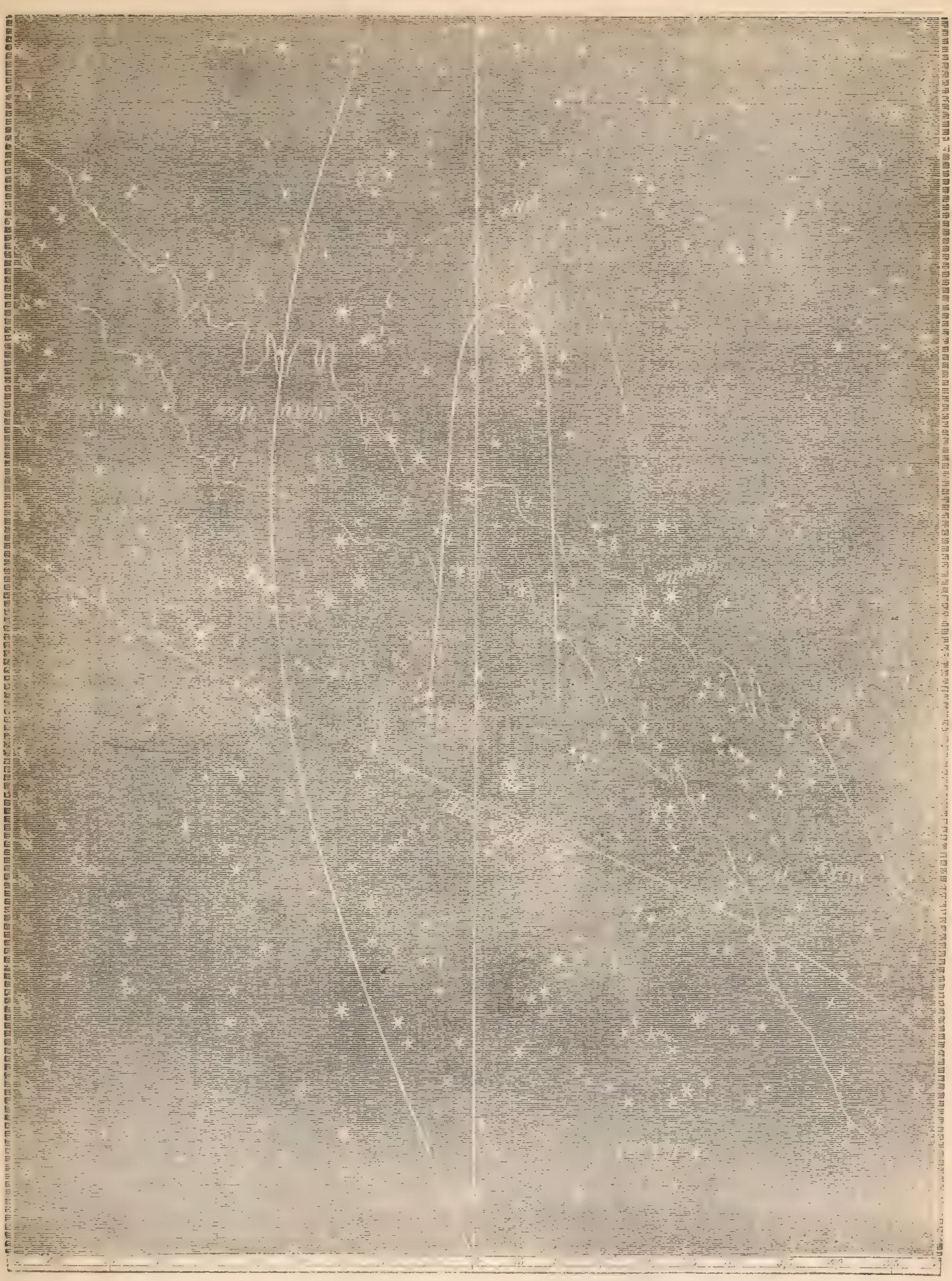


No. 133.

MARCH 28th, 1851: Evening.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun set 6*h*. 13*m*.
Stronger and Diffuse Light at 10 o'clock.

Clouds in the early part of the evening. At 10 o'clock, was able to get an observation. The Zodiacal Light dim, but perfectly distinct: the course of the Stronger Light could be readily traced across the Milky Way.

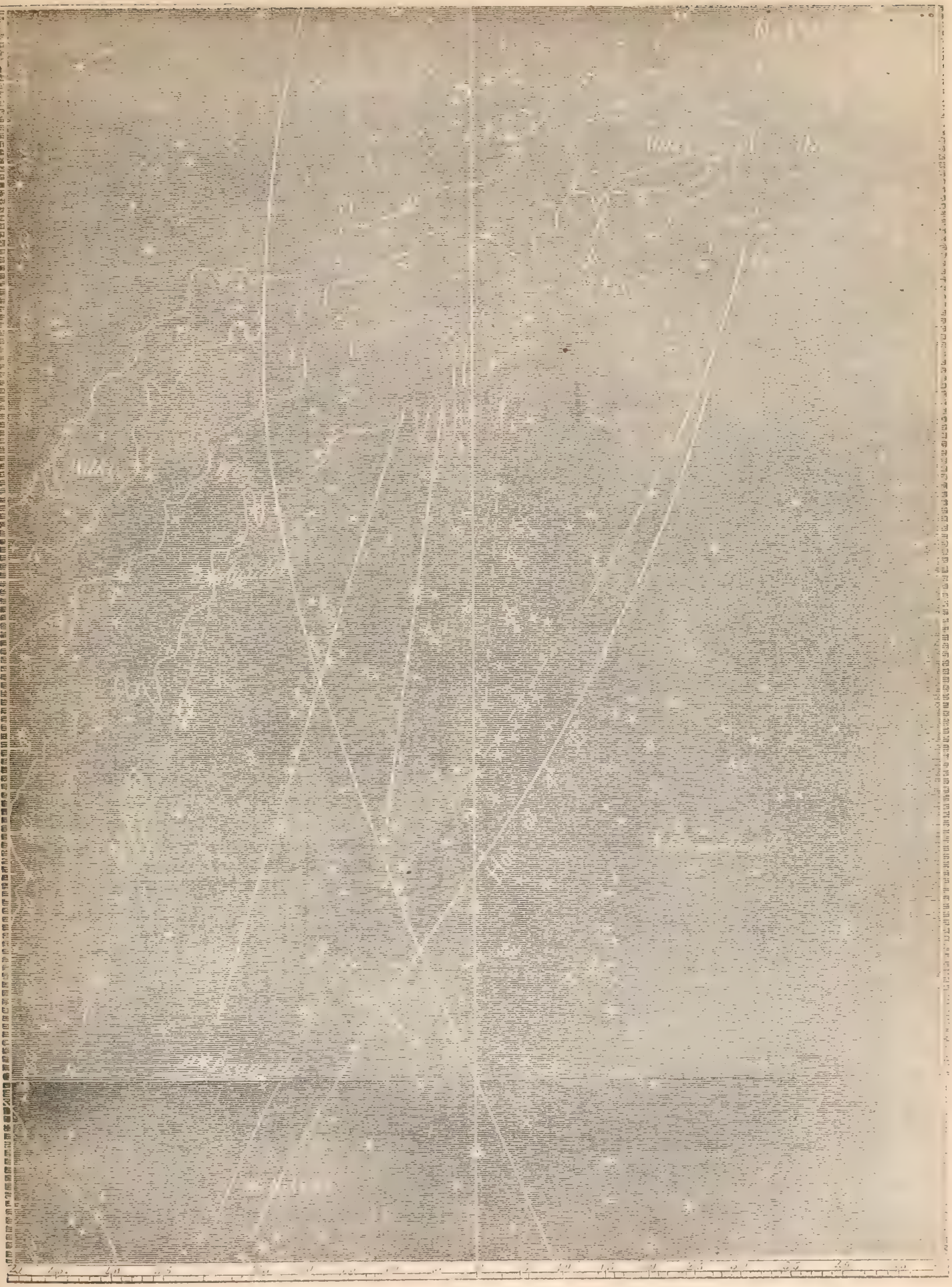


No. 134.

MARCH 29th, 1854: Morning.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun rose 5*h*. 55½*m*.
Stronger Light at 4*h*. and 4*h*. 30*m*.: Diffuse 4*h*. and 4*h*. 24*m*.
Zenith point at 4*h*. 30*m*.: Lat 58° N.: Lon 246°.

Was on deck at 4 o'clock, and got boundaries for Diffuse and Stronger Light, except the lower edge of the former, which was not decided enough till at $4^h\ 24^m$. A haze along the horizon prevented my observing any changes in the lower boundaries as the horizon sunk; there were none in the upper. Dawn at $4^h\ 40^m$.



No. 135.

MARCH 29th, 1854: Evening.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun set 6*h*. 14*m*.
Stronger Light 7*h*. 28*m*., &c., to 10*h*.: Diffuse 7*h*. 40*m*. and 9*h*.

A very favorable sky for observations. Sun set at $6^h\ 14^m$. At $7^h\ 14^m$ a whitish light all along the horizon, but runs higher up towards the Pleiades than at any other part; $7^h\ 24^m$, there is now evidently a brightness running up beyond the Pleiades, but it is not strongly enough marked to give certain boundaries. At $7^h\ 28^m$ it is quite distinct, and I get boundaries, as at *a*.

h. *m*.
At 7 31, it is at *b*.
7 32, do. brightening.
7 35, at *c*, and bright.
7 36, at *b*, and dimmed.
* * * *
7 40, at *c*, and bright.
7 43, at *b*, and now evidently dimmed.
7 44, do. do. do.
7 44½, brightening.
7 45, at *c*, and bright.
7 46½, at *b*, and dim.
7 48, at *c*, and bright.
7 49½, do. do.
7 51, at *d*, and extremely bright.
7 52⅓, at *b*, and very dim.
7 53½, brightening.
7 54½, at *d*, and very bright.
7 57½, do. still bright.

h. *m*.
At 7 58, dimming.
7 58⅔, at *b*, and dim.
7 59½, do. brightening.
8 0, do. bright.
8 1, at *d*, and bright.
8 2, do. do.
8 3, at *b*, and dim.
8 3⅔, at *b*, and brightening.
8 4½, at *d*, and bright.
8 6, at *d*, very bright.
8 12, do. still very bright, and seems to be permanent in height.
8 13, there seem to be some slight pulsations in intensity, but I cannot catch them reliably—cannot be certain about them.
10 0, found the Stronger Light up to above Castor and Pollux, and already making its course across the Milky Way.

No. 136.

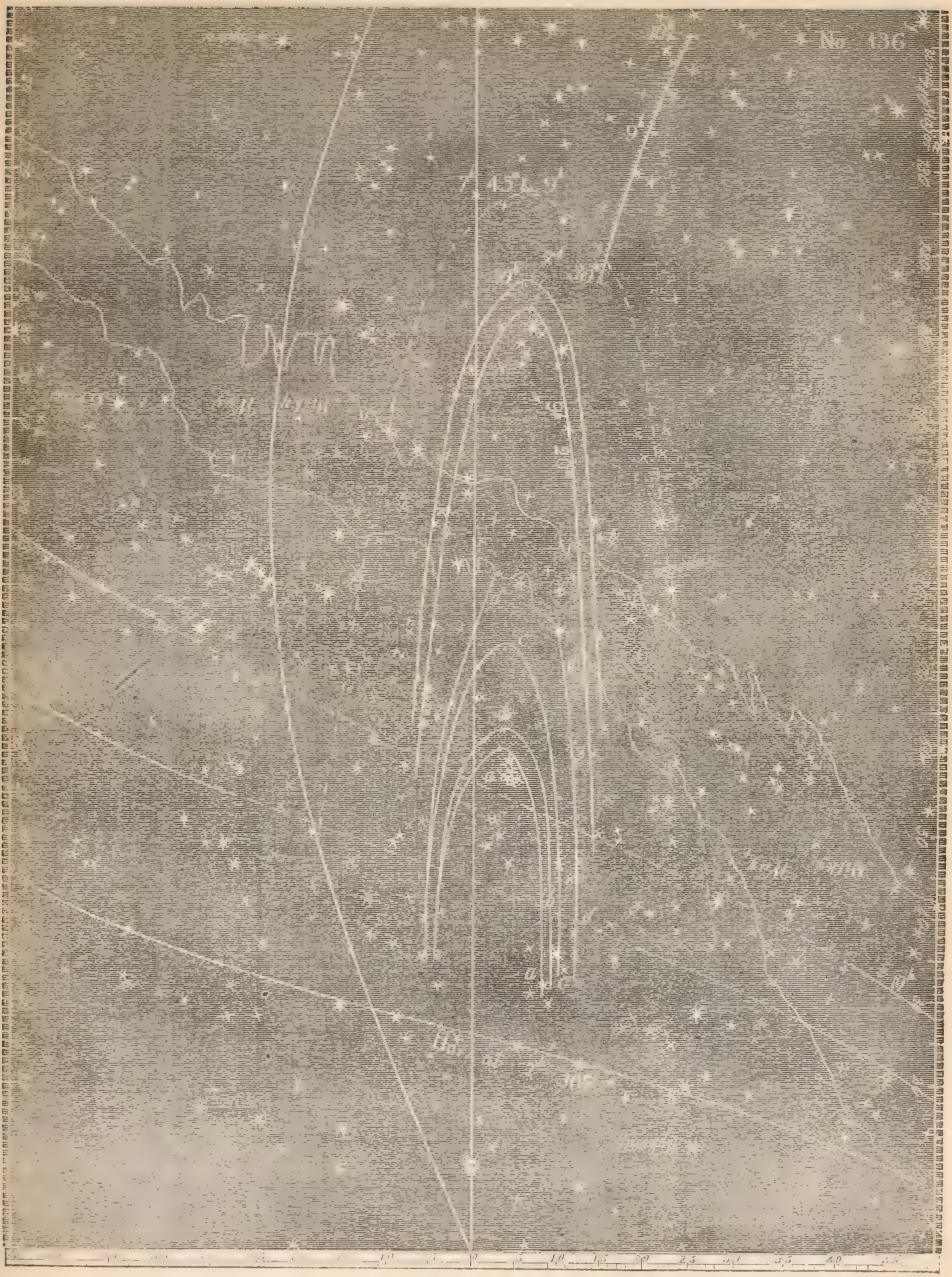
MARCH 30th, 1854: Evening.

Lat. 35° 26′ N.: Lon. 139° 42′ E.
Sun set 6*h*. 14*m*. 40*s*.
Stronger Light 7*h*. 37*m*., &c., to 10*h*.: Diffuse 7*h*. 45*m*. and 9*h*

The morning cloudy. At 7ʰ 39ᵐ this evening, there was a general whiteness within the boundaries *a a*; at 7ʰ 37ᵐ, boundaries at *c*.

h.	*m*.	
At 7	43,	at *b*, and dim.
7	44,	do. do.
7	44½,	brightening.
7	45,	at *c*, and bright.
7	47,	do. do.
7	49,	at *b*, dim.
7	50,	brightening.
7	50½,	at *c*, and bright.
7	51,	do. do.
*	* * *	Not reliable.
7	54,	at *b*, and dim.
7	54½,	brightening.
7	55½,	at *c*, and bright.
7	56¼,	at *d*, and bright.
7	57½,	at *d*, and very bright.
7	59,	dimmed.
8	0½,	at *d*, and very bright.
8	2,	extremely bright.
8	6,	still as at last.

h.	*m*.	
At 8	6⅔,	suddenly dimmed; is at *b*, and dimness, as if the light were dying away.
8	9,	do. do. do.
8	9½,	brightening.
8	10⅓,	at *d*, and bright; but not as bright as at 8ʰ 2ᵐ, &c.
8	12,	at *d*, and bright as at 8ʰ 6ᵐ.
8	13½,	at *c*, and dim.
8	15,	brightening.
8	15½,	dimmed.
8	16⅓,	dimmed.
8	17,	brightening. These last pulsations were not very distinct. I have recorded what seemed to me to be the case.
8	23,	seems to be permanent at *d*, but is considerably dimmed from what it was at 8ʰ 6ᵐ.
9	20,	Stronger Light clearly above Milky Way, and marking its course across it.
10	0,	still quite distinct.

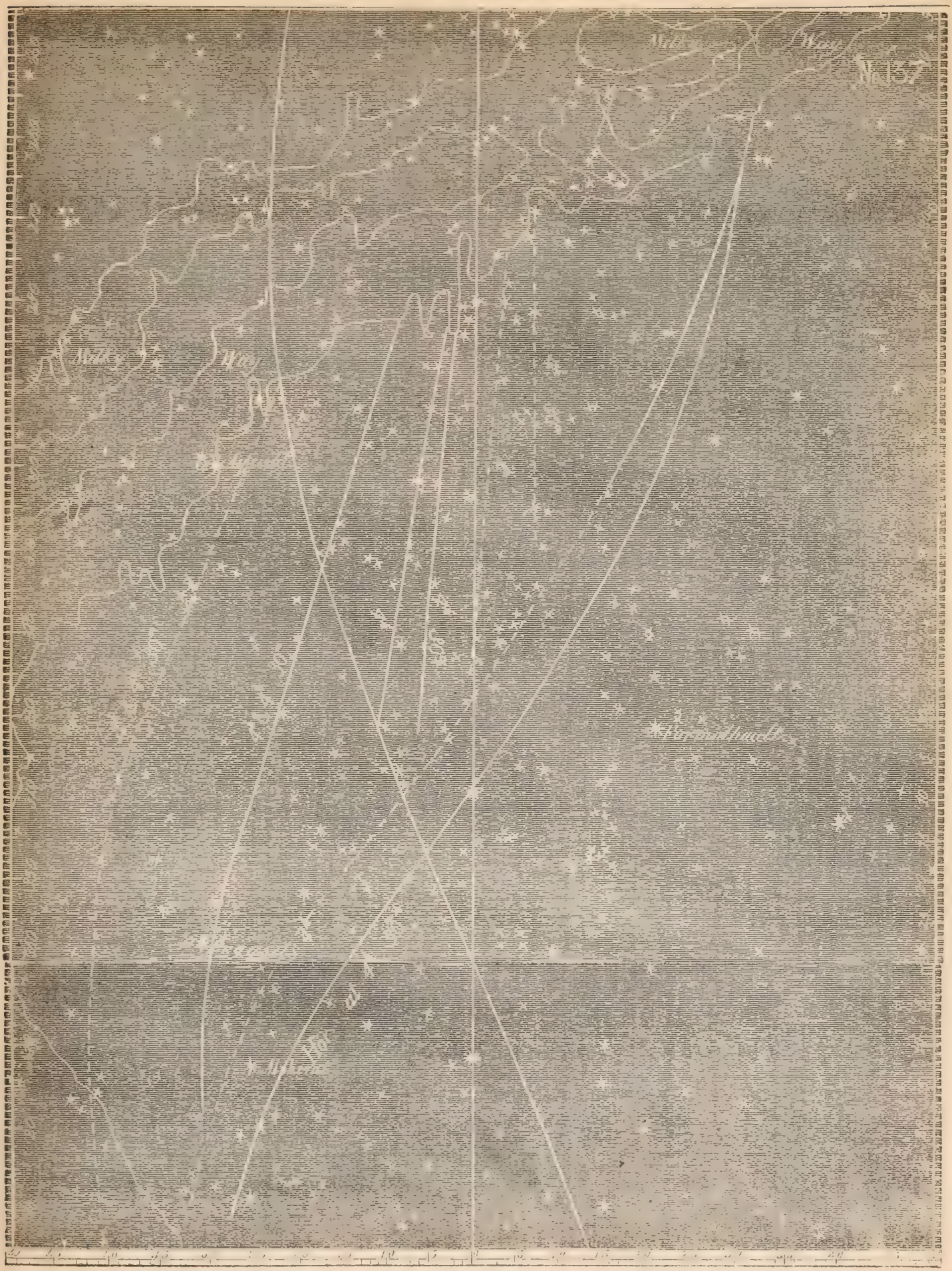


No. 137.

APRIL 1st, 1854: Morning.

Lat. 35° 26′ N.: Lon. 139° 43′ E.
Sun rose 5*h*. 51*m*.
Stronger and Diffuse Light at 4*h*. and 4*h*. 30*m*.
Zenith point at 4*h*. 3 0*m*.: Lat. 58° 30′ N.: Lon. 250° 30′.

Clouds since last. This, a fine clear morning, excellent for observations. Got boundaries at 4^h and $4^h\ 30^m$: it is difficult, however, at $4^h\ 30^m$, to ascertain the dividing line between the Stronger and the Diffuse Light on the left hand; the Diffuse Light itself being strong. Have given them as they appeared to me to be. At $4^h\ 30^m$, I thought I saw an increase of light shoot suddenly along within the boundaries of the Stronger, and that this increased light remained, but would not be certain of it. At $4^h\ 41^m$, decidedly dawn. Have drawn the boundary of the Diffuse Light across the Milky Way, near the horizon; it being strong enough to make itself evident there.



No. 138.

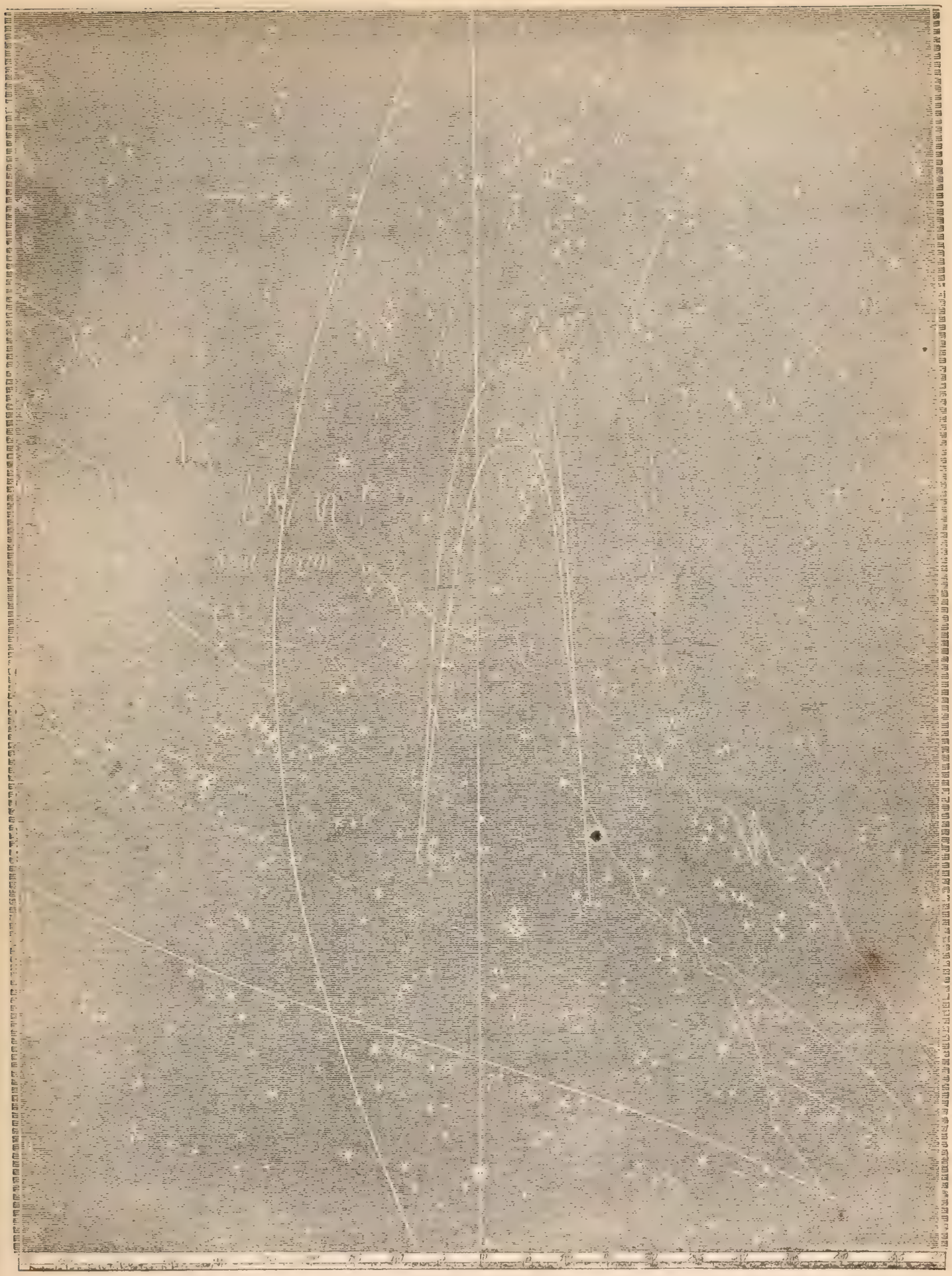
APRIL 17th, 1854: Evening.

Lat. 35° 19′ N.: Lon. 139° 43′ E.

Sun set 6*h*. 29½*m*.

Stronger and Diffuse Light	7*h* 35*m*.
	8 45
	9 30
	10 30

Clouds ever since last date, except one evening, and then the moon (at full) prevented observations. This evening, the sky above was not very clear, and there was a thick haze along the horizon; but still I had some good observations. If there were any pulsations, I could not see them on account of the haze. The times of observation and results are given in the chart.

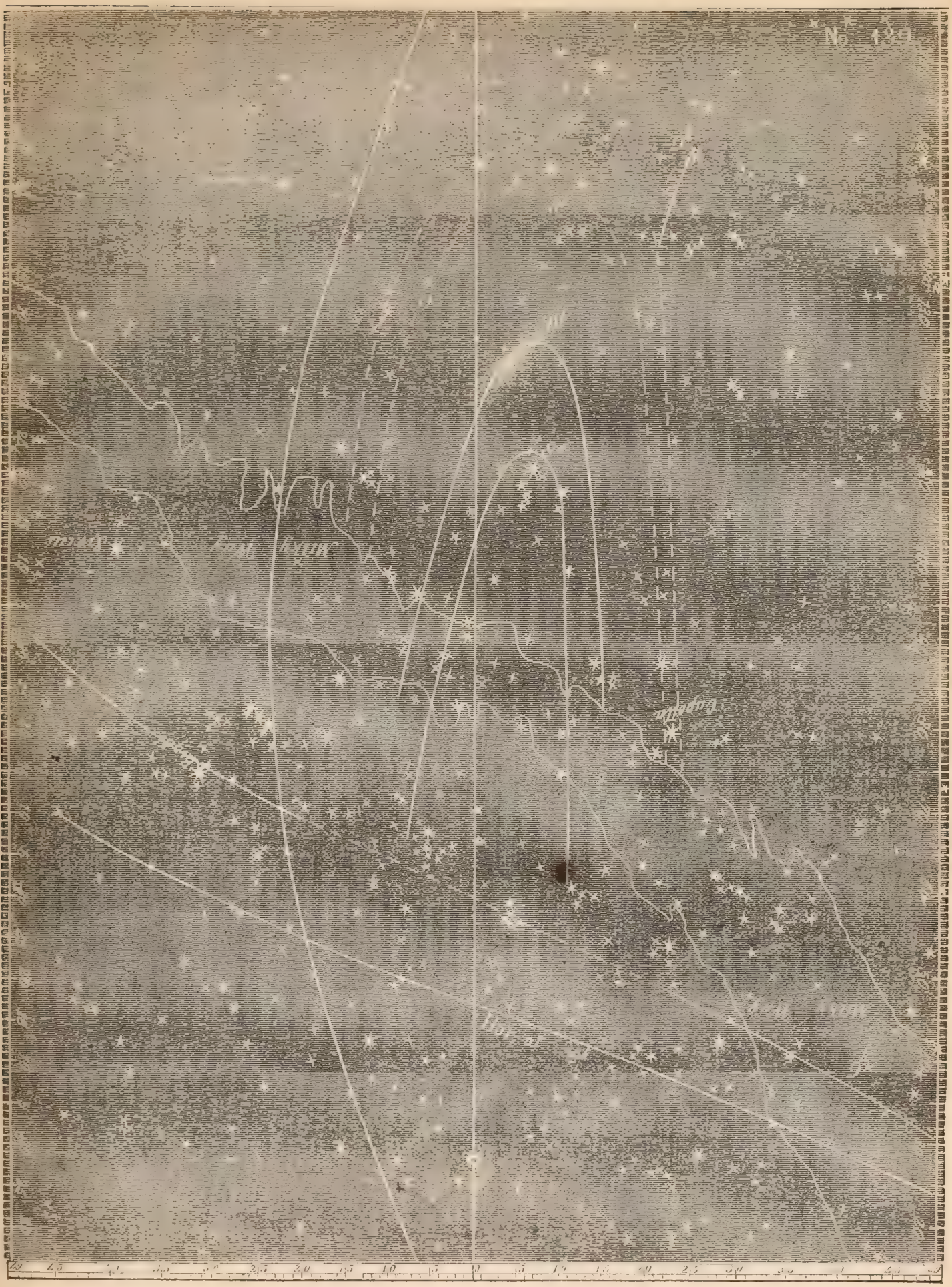


No. 139.

APRIL 18th, 1854: Evening.

Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun set 6*h*. 30*m*.
Stronger and Diffuse Light, 8 and 9 o'clock.

The mornings are now very hazy, the sky covered with clouds. As the day advances, the clouds are dissipated, and the haze becomes thinner; till, in the evening, the sky admits of observations, though not perfectly clear. This evening, although there was a white light within the Zodiacal Light limits at an earlier hour, I could not get reliable boundaries till 8 o'clock. After 9^h, clouds interfered. In this haze, it was not easy to get the boundaries of the Diffuse Light; but I believe that those given in the chart may be depended on.



No. 140.

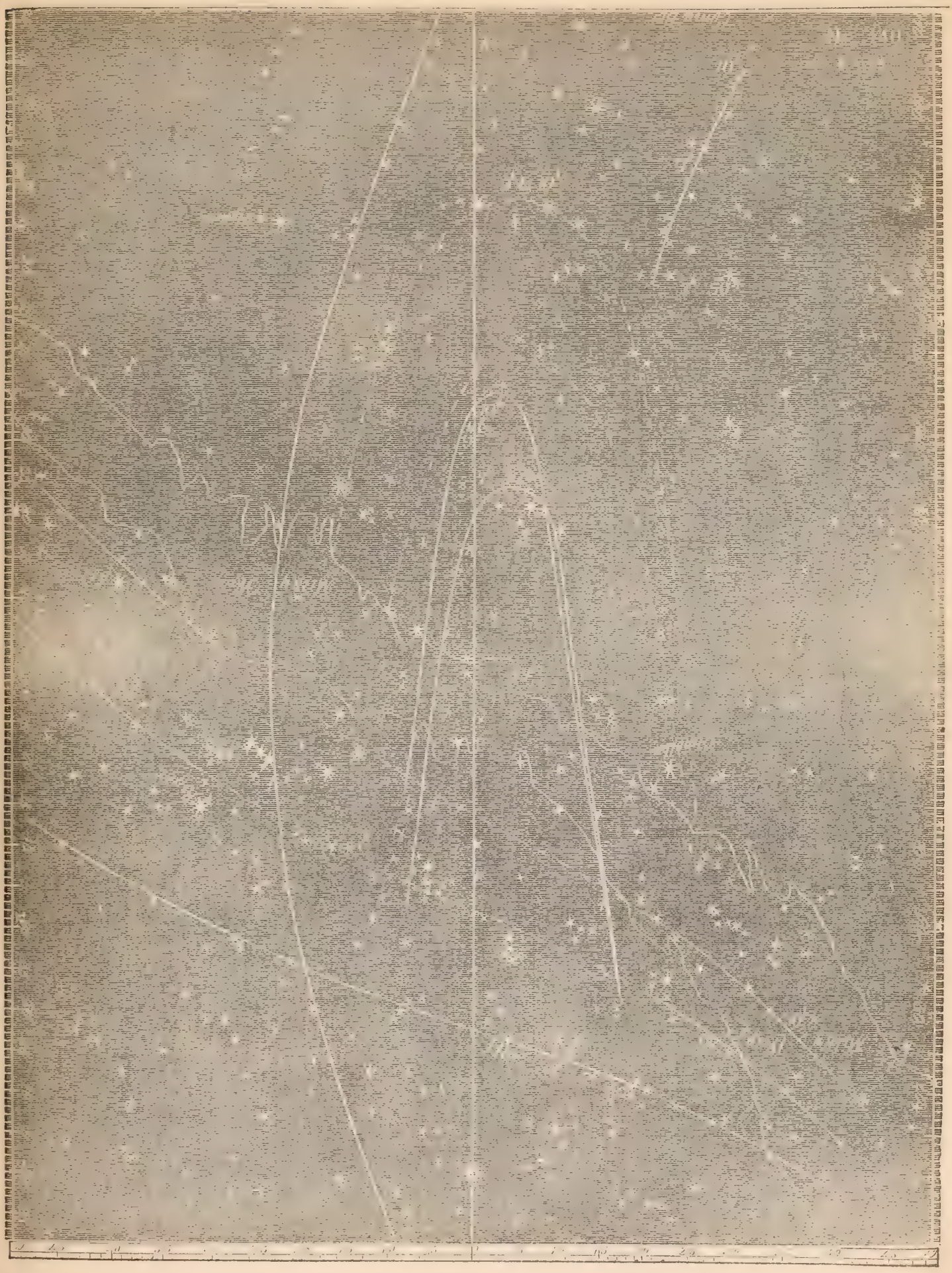
APRIL 20th, 1854: Evening.

Lat. 34° 40′ N : Lon. 135° 59′ E.

Sun set 6*h*. 31*m*

Stronger Light { 7 50*m* / 9 0 / 10 0 } Diffuse 8*h*., 9*h*., and 10*h*.

Last night cloudy. This evening very clear and bright. Watched for the first appearance of the Zodiacal Light. At 7ʰ 44ᵐ it showed itself; but it did not give reliable boundaries till 7ʰ 50ᵐ. The Stronger Light evidently moves over towards the left as the evening advances; probably owing to the change in the obliquity of the ecliptic. At 10ʰ, the boundaries appeared to be the same as at 9ʰ; but it was difficult then to get the bounds of the Stronger Light, especially on the left, or south. The Diffuse Light is now very bright, particularly towards the southern side.



No. 141.

APRIL 21st, 1854: Evening.

Lat. 34° 40′ N.: Lon. 138° 59′ E.

Sun set 6*h*. 32*m*.

Stronger Light { 7*h*. 52*m*. / 9 0 / 10 0 } Diffuse, 8*h*., 9*h*., and 10*h*.

A very clear night. At 7^h 40^m there was a whitish light distinguishable, extending up to Castor and Pollux; at 7^h 52^m I was able to get reliable boundaries, as in the chart. The sky was so remarkably favorable for observations in every respect, that I looked out carefully for pulsations, but was not able to see any. Two or three times I thought the Light faded a little; but there was nothing reliable, and I concluded, finally, that there were no pulsations. At 10^m the Light was still very distinct; the Diffuse Light grows stronger as the night advances (to a certain point), and at 10^h it is difficult to distinguish between it and the Stronger Light; but I thought the boundaries of both were about the same as at 9^h.

No. 141

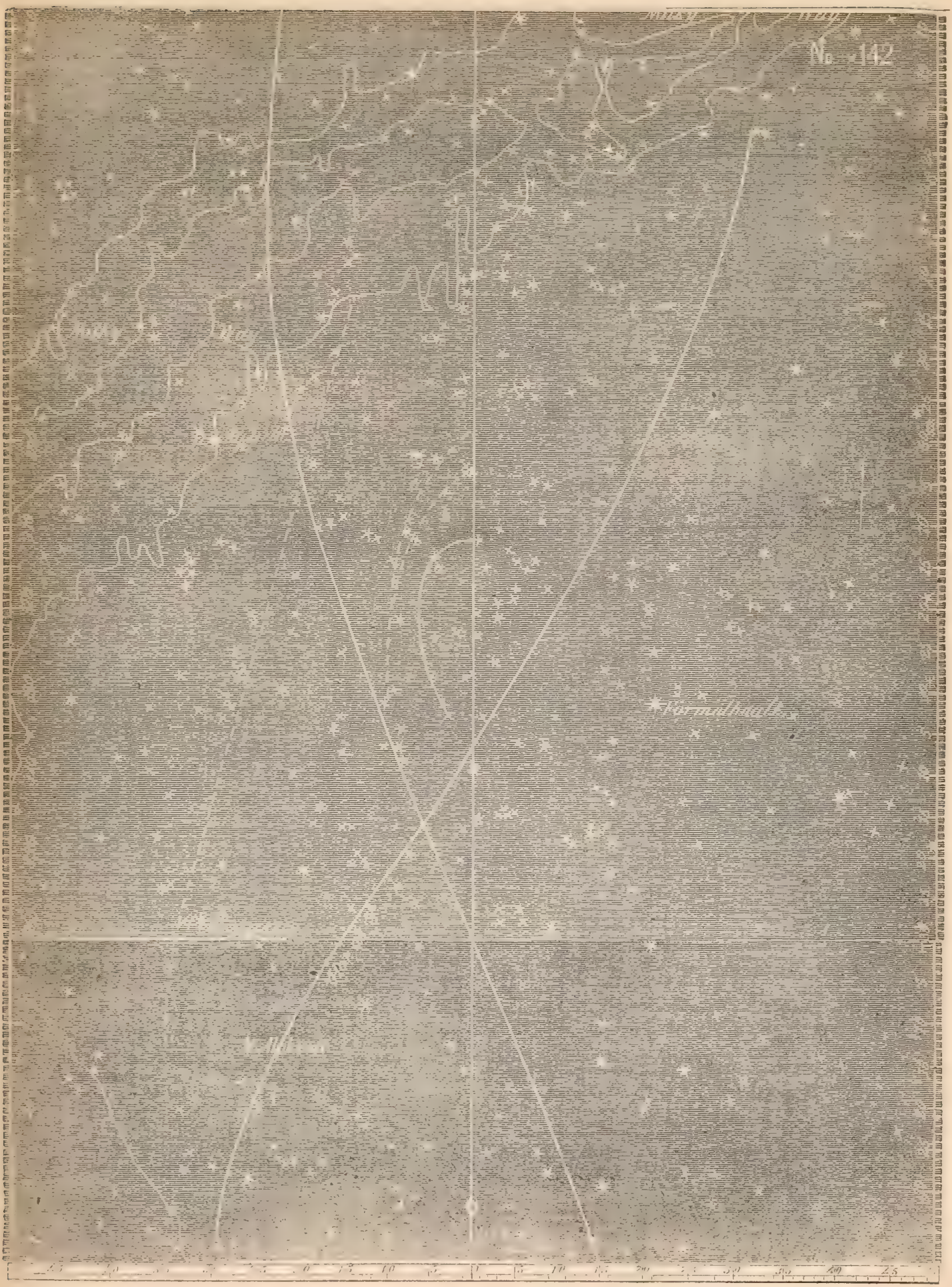
No. 142.

SUN AND MOON.

APRIL 22d, 1854: Morning: (Monday)
Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun rose 5*h*. 24½*m*.
Sun, Diffuse 2*h*. 45*m*.: Moon, Stronger 3*h*. 18*m*.; Diffuse 2*h*. 57*m*. and 3*h*. 3*m*.
Zenith point at 3*h*.: Lat. 57° 40′ N.: Lon. 249°.

Was on deck at $2^h\ 35^m$. Morning remarkably clear, with stars, seaward, down to the horizon; on the east, some hills in the way. At that early hour the Zodiacal Light was easily distinguishable, and I got the upper boundary of the Diffuse at $2^h\ 45^m$; the lower was hidden by the hills. At $2^h\ 50^m$ the Light began to brighten at its lower side, and I saw the moon had got near enough to affect it. Took the upper boundary *b* of this Moon Zodiacal Light at $2^h\ 57^m$; and at $3^h\ 3^m$, *c*; at $3^h\ 18^m$ there was a great brightening in a part within the boundary *a*; at $3^h\ 24^m$, the moon showed itself above the hill.

The observation was unsatisfactory, for the moon came so early as to prevent a good Sun Zodiacal Light, and was not strong enough to give a good one from its own light; but I give the result for what it is worth.

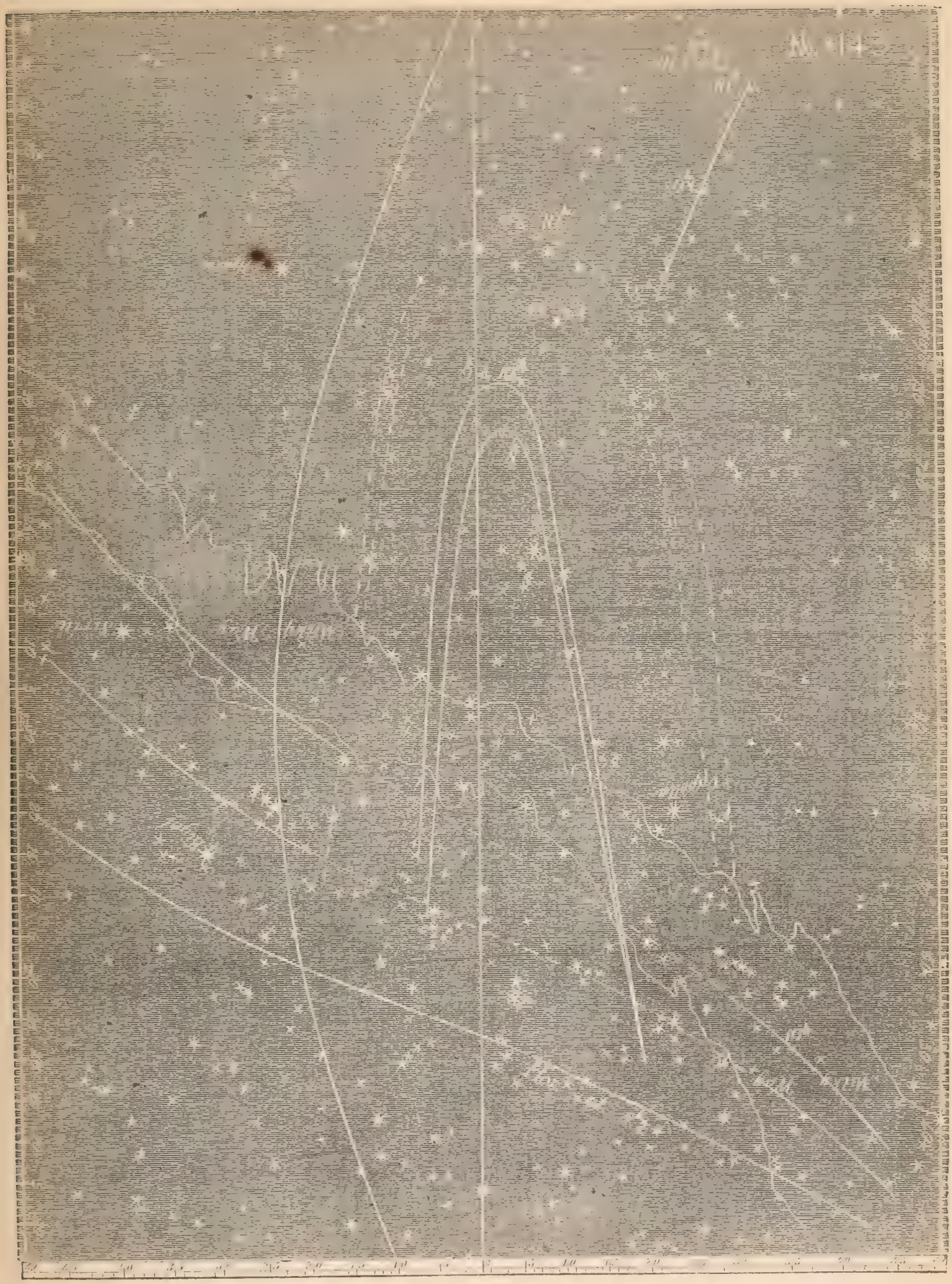

No. 112

No. 145.

APRIL 24th, 1854. EVENING.

Lat. 34° 40′ N.: Lon. 135° 59′ E.
Sun set 6*h*. 36*m*.
Stronger and Diffuse Light at 8*h*., 9*h*., and 10*h*.

Clouds since last date till this evening, which, also, was cloudy till 8^h; but, from that on, very clear and bright. For results, see chart. At 10^h the boundaries appeared to be as at 9^h; but it was difficult to get them. The Diffuse Light had, perhaps, ascended a little; but I could not tell with certainty. Thought, sometimes, that the Stronger Light pulsated on its northern side.



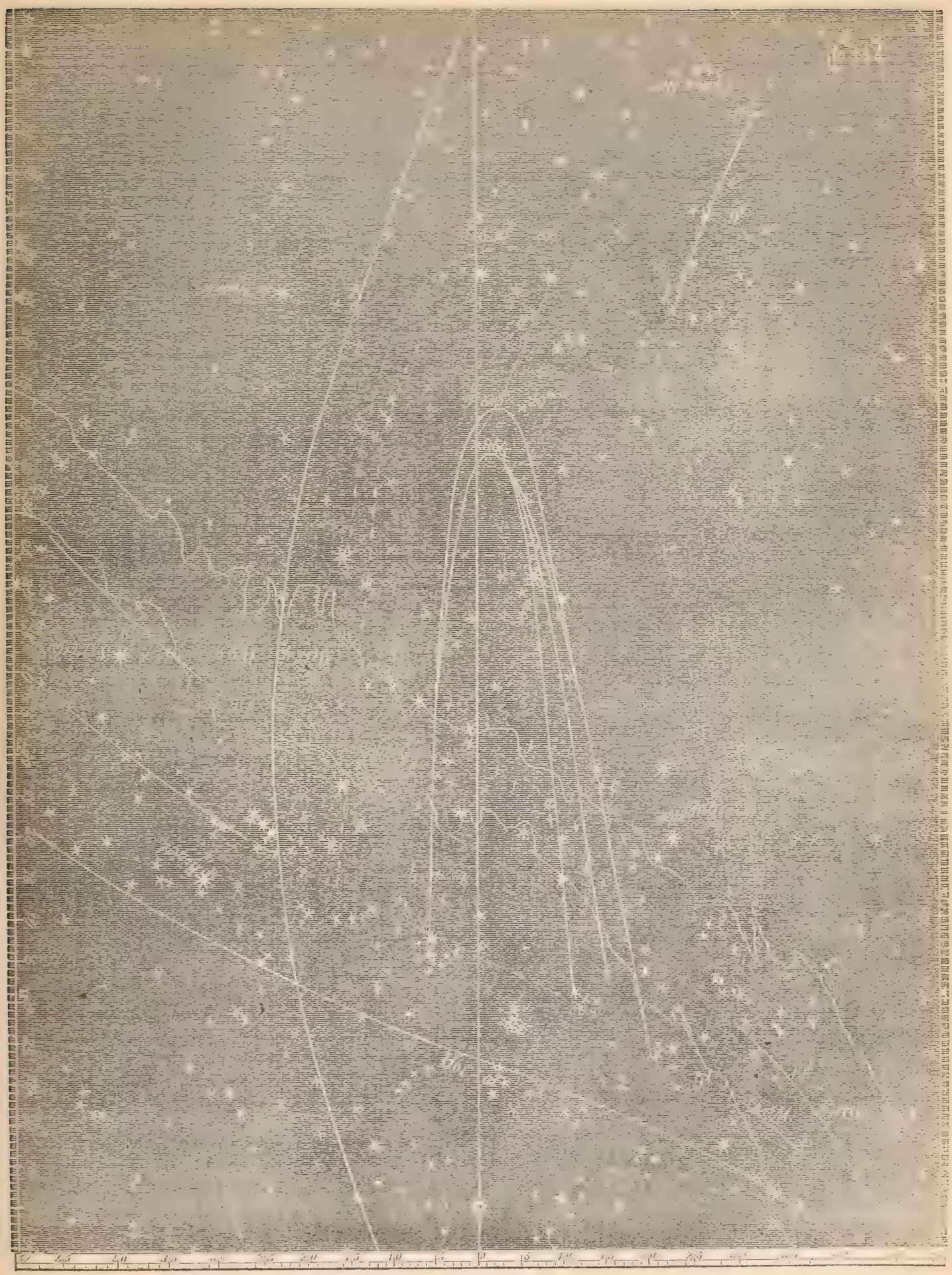
No. 144.

APRIL 25th, 1854: EVENING.
Lat. 34° 40′ N.: Lon. 135° 59′ E.
Sun set 6*h*. 35*m*.
Stronger and Diffuse Light at 8*h*., 9*h*., and 10*h*. 20*m*.

A fine clear night. At 7ʰ 46ᵐ the Zodiacal Light was distinct up to Castor and Pollux; could not get boundaries till 7ʰ 55ᵐ, when the Stronger Light was at *b*. At 8ʰ 7ᵐ it was very strong, and I began to think that this great and rapid increase of light must belong to pulsations. Watched, therefore, carefully (as the night, very clear, was so far a favorable one), to have further proofs one way or the other. The Milky Way crossing the Zodiacal Light was against such observations; but I soon became pretty well satisfied that there were pulsations in intensity, and also in the boundary on the right or northern side. My notes, taken at the time, were as follows:

h. *m*.
At 7 55, at *b*.
8 7, strong.
8 10, dimmed, and at *a*.
8 15, dim, do.
8 17, at *c*, and bright.
8 22, *decidedly* at *c*, and bright.
8 23, do. do.
8 24, dimming.
8 24½, at *a*, and decidedly dimmed.
8 26, do. do.
8 28, brightening.

h. *m*.
At 8 32, at *c*, and bright.
8 34, do. and very bright.
8 36, do. do.
8 37, do. dimmed.
8 42, do., seems to be still dim; but there is now so little space between the Milky Way and horizon, that it is difficult to judge, and I give up observing.
10 20, the boundaries were apparently as at 9ʰ, but the light was all very dim.

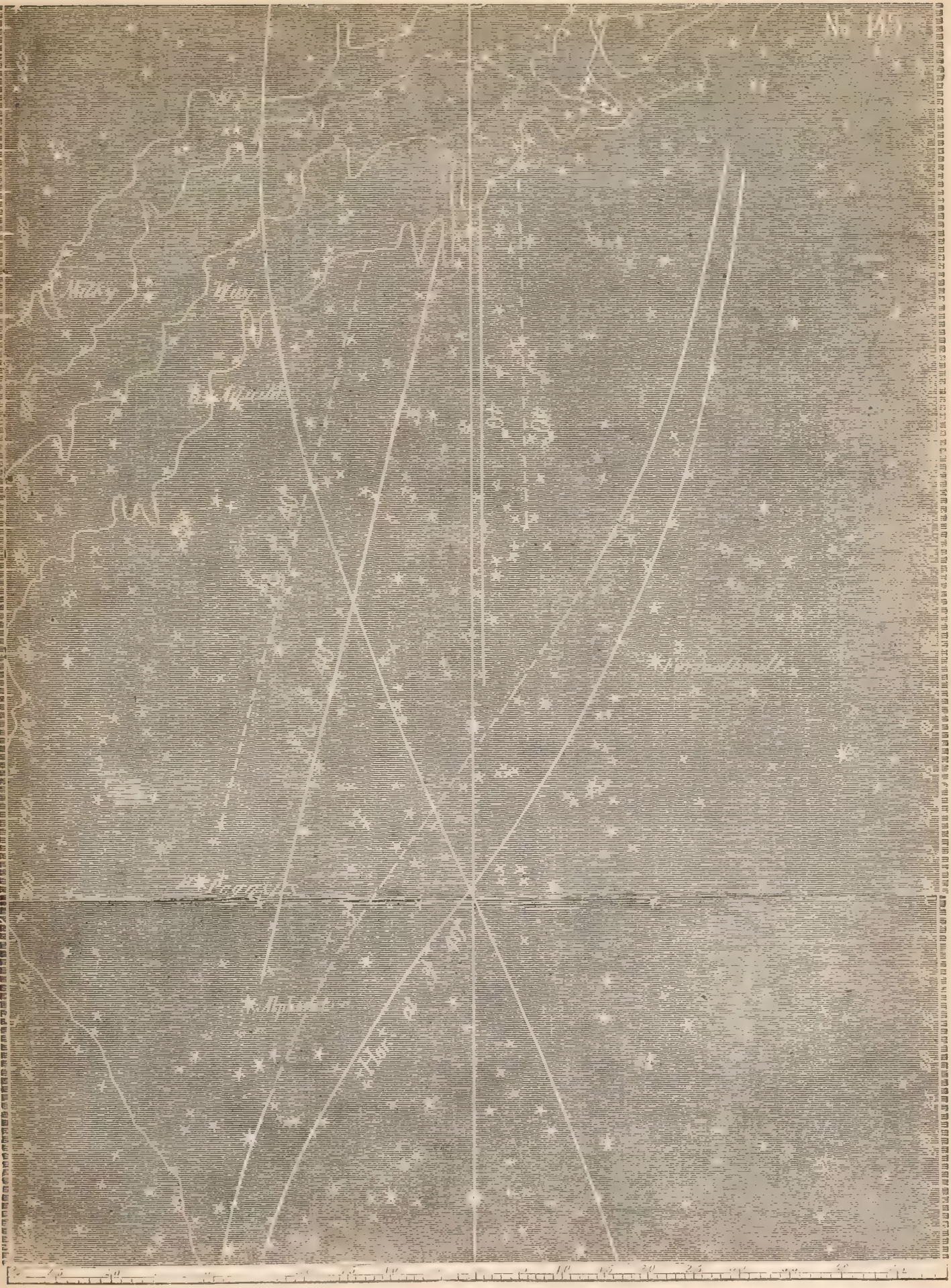


No. 145.

APRIL 26th, 1854: Morning.

Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun rose 5*h*. 20*m*.
Stronger and Diffuse Light at 3*h*. and 3*h*. 40*m*.
Zenith point at 3*h*. 40*m*.: Lat. 55° 5′ N.: Lon. 270°.

Clouds in the morning since my last morning date. Was on deck at 3^{h} this morning, and was able to get boundaries on the upper side of the Zodiacal Light. The Light, however, was dim; both then, and till dawn, much dimmer than on the first of this month, and for some time previous. The glare from Jupiter is also now troublesome. At 3^{h} 40^{m} got boundaries on both sides, but found the Diffuse Light ill defined on its lower side. Dawn at 4^{h} 5^{m}.

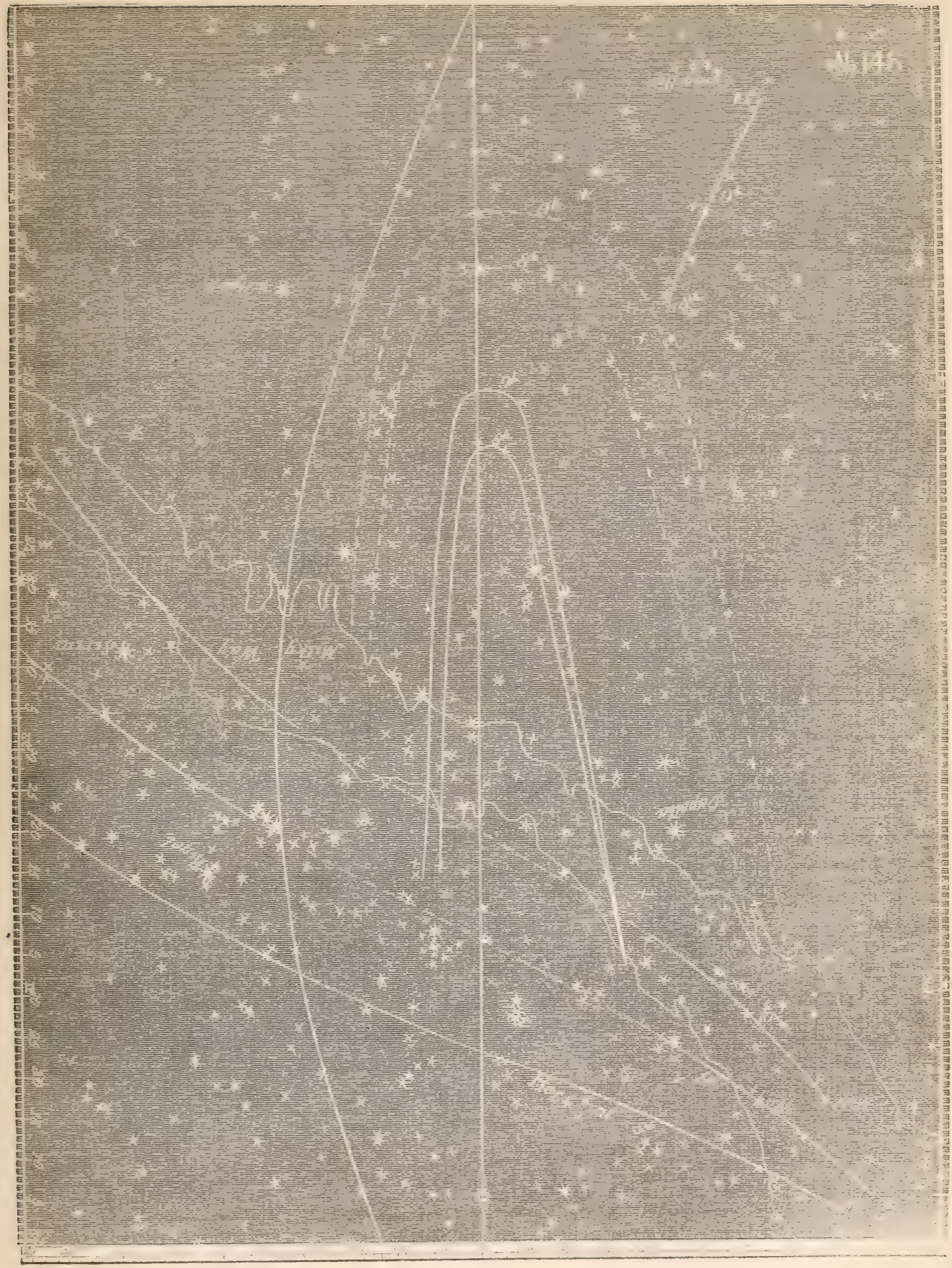


No. 146.

APRIL 26th, 1854: Evening.

Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun set 6*h*. 36*m*.
Stronger and Diffuse Light at 8 and 9 o'clock.

Evening hazy, and by no means favorable; still, was able to get observations at 8^h and 9^h, which may be considered tolerably reliable. Did not look for pulsations, as, if there were any, the sky evidently would not admit of their being seen. At 10^h there was still a Zodiacal Light, but it was dim and undefined.

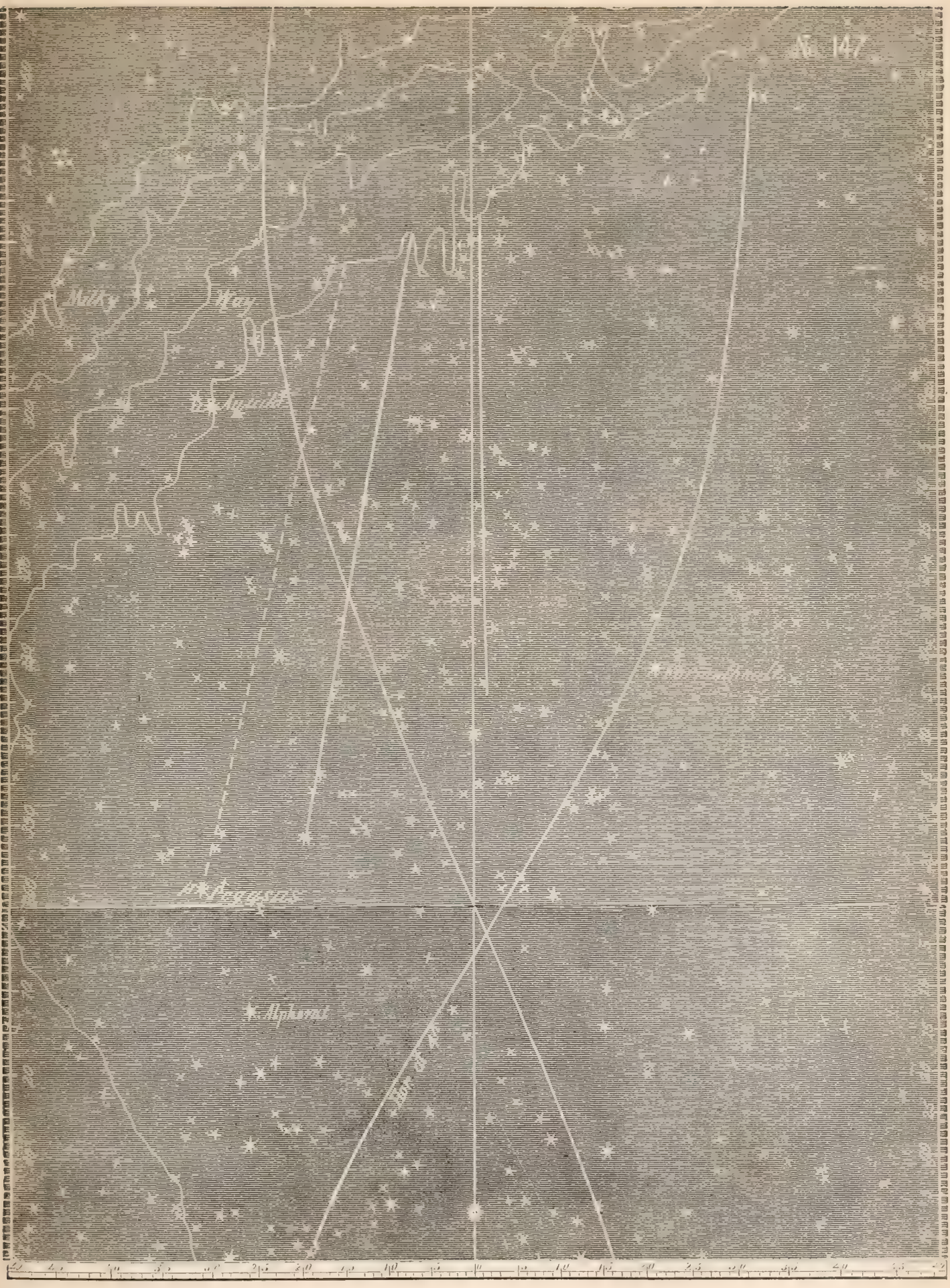


No. 147.

APRIL 27th, 1854: Morning.

Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun rose 5*h.* 19½*m.*
Diffuse and Stronger Light at 4 o'clock.
Zenith point at 4*h.*: Lat. 58° 25′ N.: Lon. 279°.

Morning hazy, and the observations very unsatisfactory. It was not till 4 o'clock that I was able to get boundaries; and them I should scarcely have known how to draw, but from knowledge gained from observations on previous mornings. With such guidance, I was able to trace the outlines; but this, consequently, cannot be considered an independent observation; and it is therefore not fully reliable.


No. 147
Milky Way
Markab
Alpheratz
Algenib
Scheat

No. 148.

APRIL 28th, 1854: Evening.

Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun set 6*h*. 38*m*.
Stronger and Diffuse Light at 8*h*. 30*m*. and 9*h*. 30*m*.

Last evening the haziness of the atmosphere was so great that I could get no reliable boundaries. The sky, this evening, was clear, except towards the horizon. Having been on shore till a later hour than usual, I was not able to get observations till $8^h\ 30^m$; when, and at $9^h\ 30^m$, I got boundaries. In consequence of the proximity of the Milky Way to the horizon, and the haziness beneath, I was not able to make any observations for pulsations.

No. 148

No. 149.

APRIL 29th, 1854: Evening.

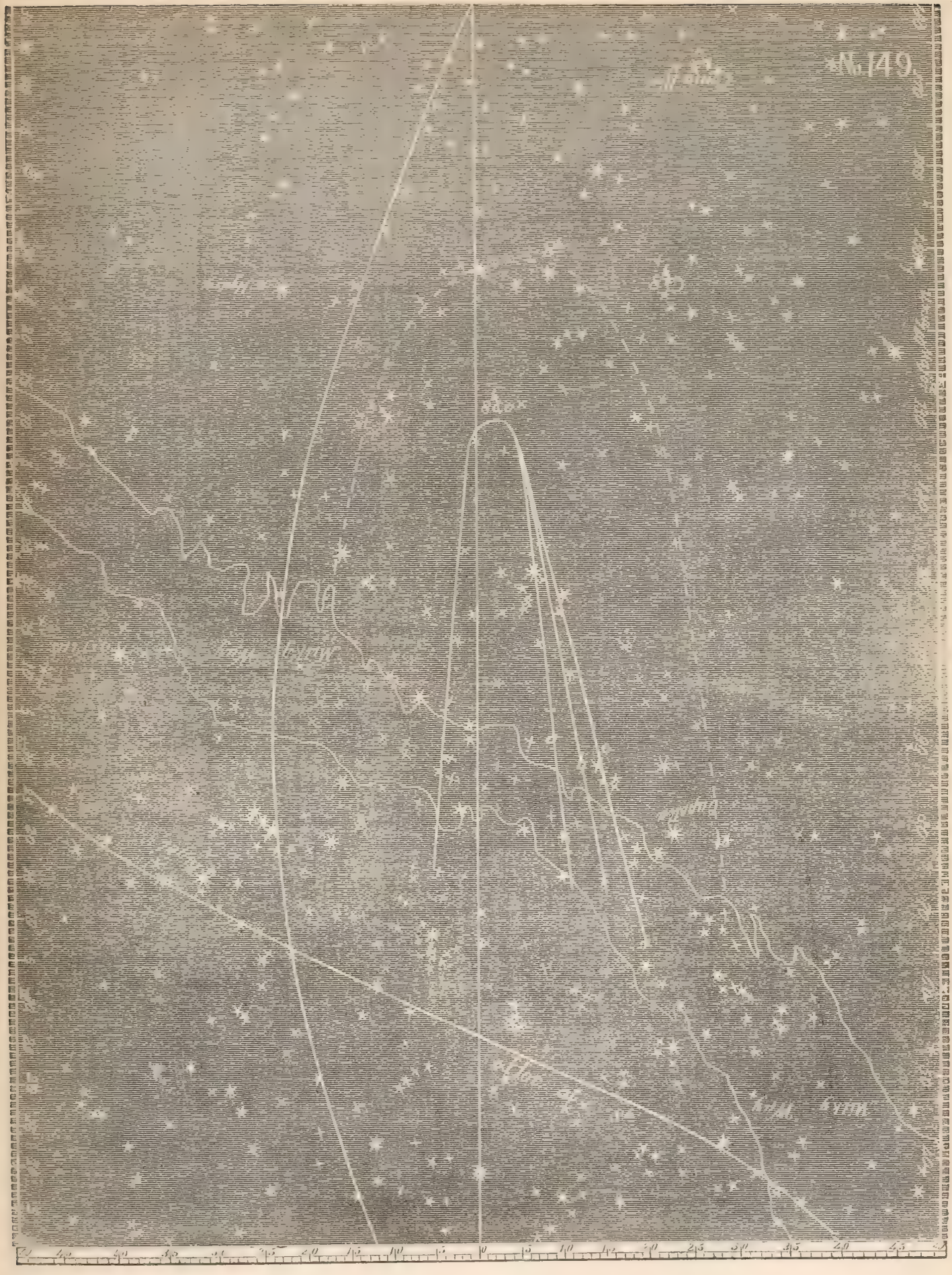
Lat. 34° 40′ N.: Lon. 138° 59′ E.
Sun set 6*h*. 38*m*.
Stronger Light at 8*h*., &c.: Diffuse at 8 o'clock.

Morning hazy. Sky, this evening, clear in the west, at 8 o'clock. Got observations at that hour. I thought, this evening, that I could see pulsations distinctly even *across* the Milky Way. My notes are as follows:

h. *m*.	*h*. *m*.
At 8 13, at *b*, and bright.	At 8 16½, at *c*, and bright.
8 14½, at *a*, and dim.	8 17½, do. and quite bright.
8 15, do. very dim.	8 18½, do. do.
8 15½, brightening.	

At 8^h 18½^m, clouds began to float across the Zodiacal Light boundaries, and I could get no further observations. At 9^h, sky quite clouded over.

The superior brightness of the Zodiacal Light over that of the adjoining portions of the Milky Way was, this evening, very striking.


No. 149

No. 150.

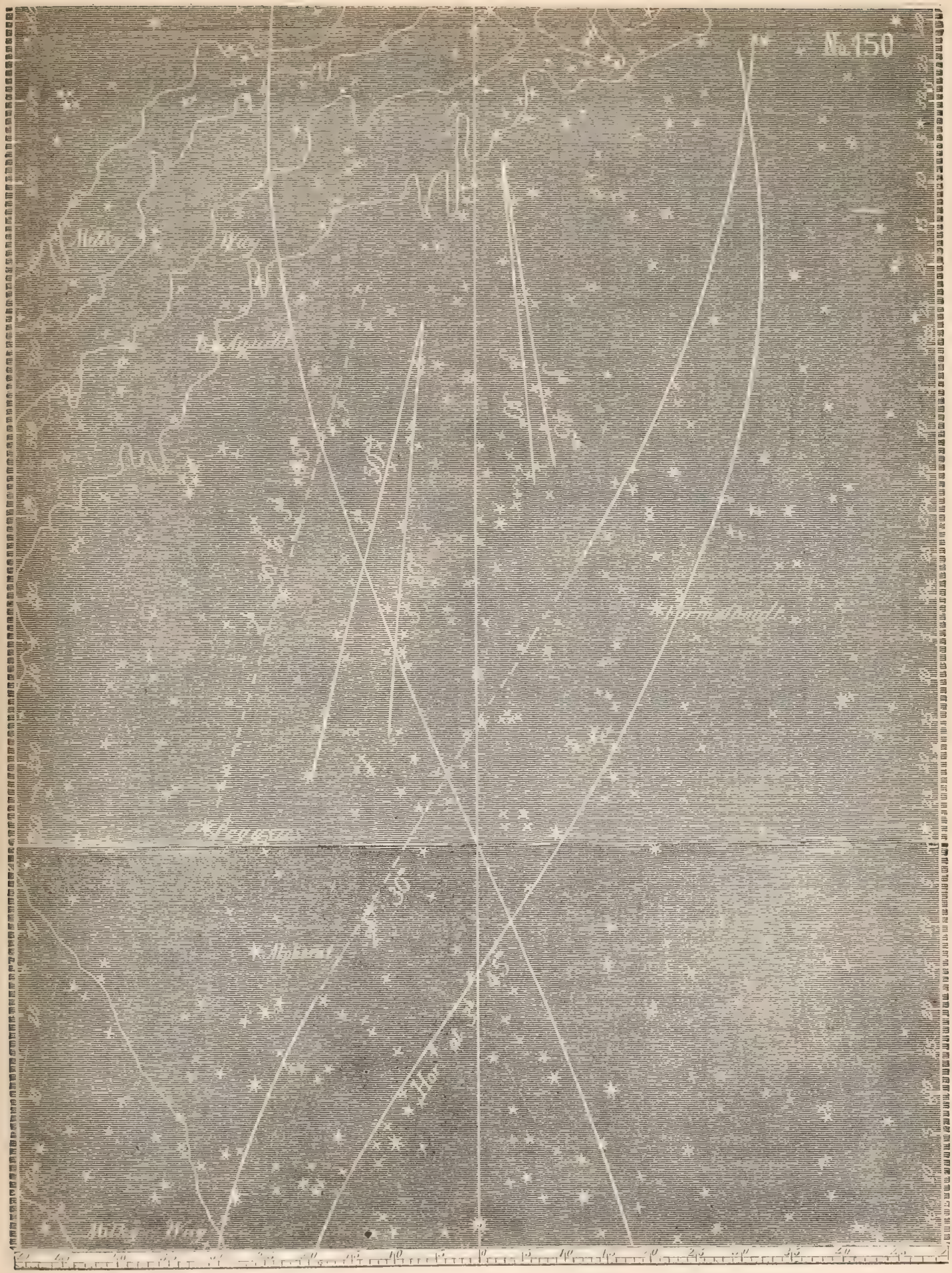
MAY 6th, 1854: MORNING.

Lat. 34° 40′ N.; Lon. 138° 59′ E.

Sun rose 5*h*. 10*m*.

Stronger Light at { 3*h* 20*m*. / 3 30 / 3 45 / 3 50 } Diffuse 2*h*. 30*m*. and 3*h* 45*m*.

Clouds uniformly since my last date, until this morning. Was on deck at $2^h\ 30^m$, and again from 3 o'clock till dawn, watching carefully, and noting down boundaries as I could get them. But these morning observations are very unsatisfactory. There is now always some haziness (the sun, at mid-day, not giving a full and clear light); and the angle between the ecliptic and the horizon is small towards morning. Jupiter's light also produces embarrassment. In my efforts at getting the upper end of the Zodiacal Light, I had to note down portions of the boundaries this morning, at different times, as I was able to make them out. It seemed to me that the Zodiacal Light was more decided at $2^h\ 30^m$ than at $3^h\ 45^m$. Indeed, at the best, I should scarcely have known where to draw the boundaries, if former knowledge had not come to my help. This morning's result, therefore, can scarcely be considered an independent one. Dawn about 4 o'clock.


No. 150
Milky Way
Algenib
Algol
Perseus
Hamal
Aldebaran
Pleiades
Milky Way

No. 151.

MAY 8th, 1854: MORNING.

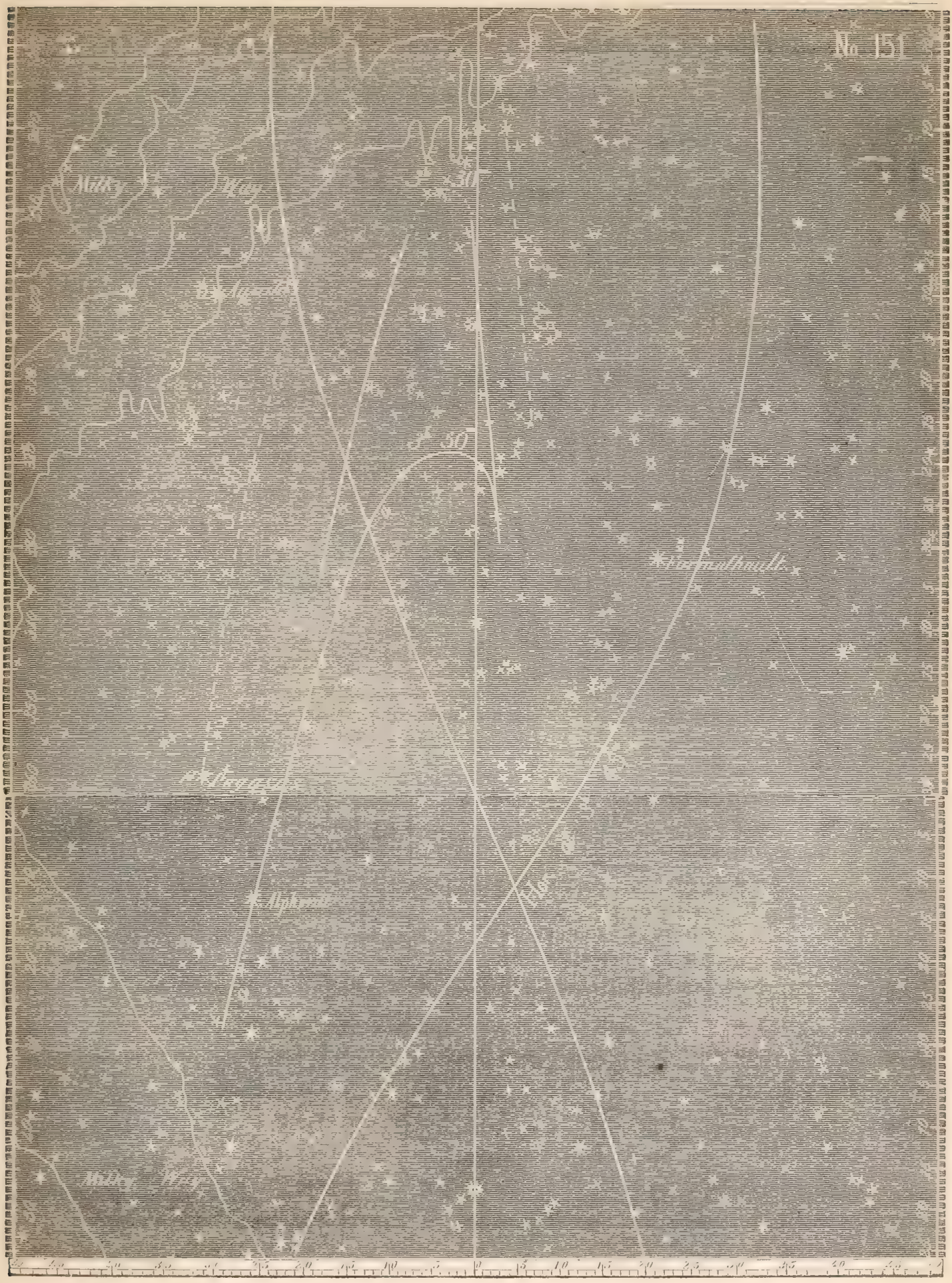
Lat. 34° 40′ N.: Lon 138° 59′ E.

Sun rose 5*h*. 8*m*.

Stronger Light { 3*h*. 30*m*. / 3 50 } Diffuse 3*h*. 30*m*. and 3*h*. 45*m*.

Zenith point at 3*h*. 45*m*.: Lat. 57° 25′ N.: Lon. 291°.

Cloudy yesterday morning. This a. m. was on deck at $3^h\ 10^m$; the morning clearer than on the 6th, but still hazy. Boundaries tolerably distinct; thought that the upper end of the Stronger Light terminated short of the Milky Way, at the place marked by dotted lines in the chart; but was not certain, as Jupiter's light was dazzling to the eyes. Towards daybreak, a very strong light began to show itself within the line marked *a a* ($3^h\ 50^m$). Day dawned about 4 o'clock.


No. 151
Milky Way
30°
Alphard
Alphard
Milky Way

No. 152.

MAY 15th, 1854: Evening.

Lat. at 8 o'clock, 40° 13′ N.: Lon. 142° 52′ E.

Sun set 7*h*. 3*m*.

Stronger Light { 8*h*. 40*m*. / 9 12 } Diffuse 8*h*. 45*m*. and 9*h*. 15*m*.

Clouds uniformly since the 8th, except last evening (Sunday). This evening the sky was cloudless; but there is now, day and night, a haziness in the atmosphere; and this interfered a little this evening; but still I was able to have a good observation. The Zodiacal Light began to show itself decidedly at $8^h\ 27^m$; but I was not able to get boundaries till $8^h\ 40^m$. Those of the Stronger Light would probably have extended up higher if the haziness had not existed. For the same reason, I did not care about watching closely for pulsations. After $9^h\ 30^m$, I was too much engaged in looking for a Moon Zodiacal Light to take further boundaries in the west.

No. 152

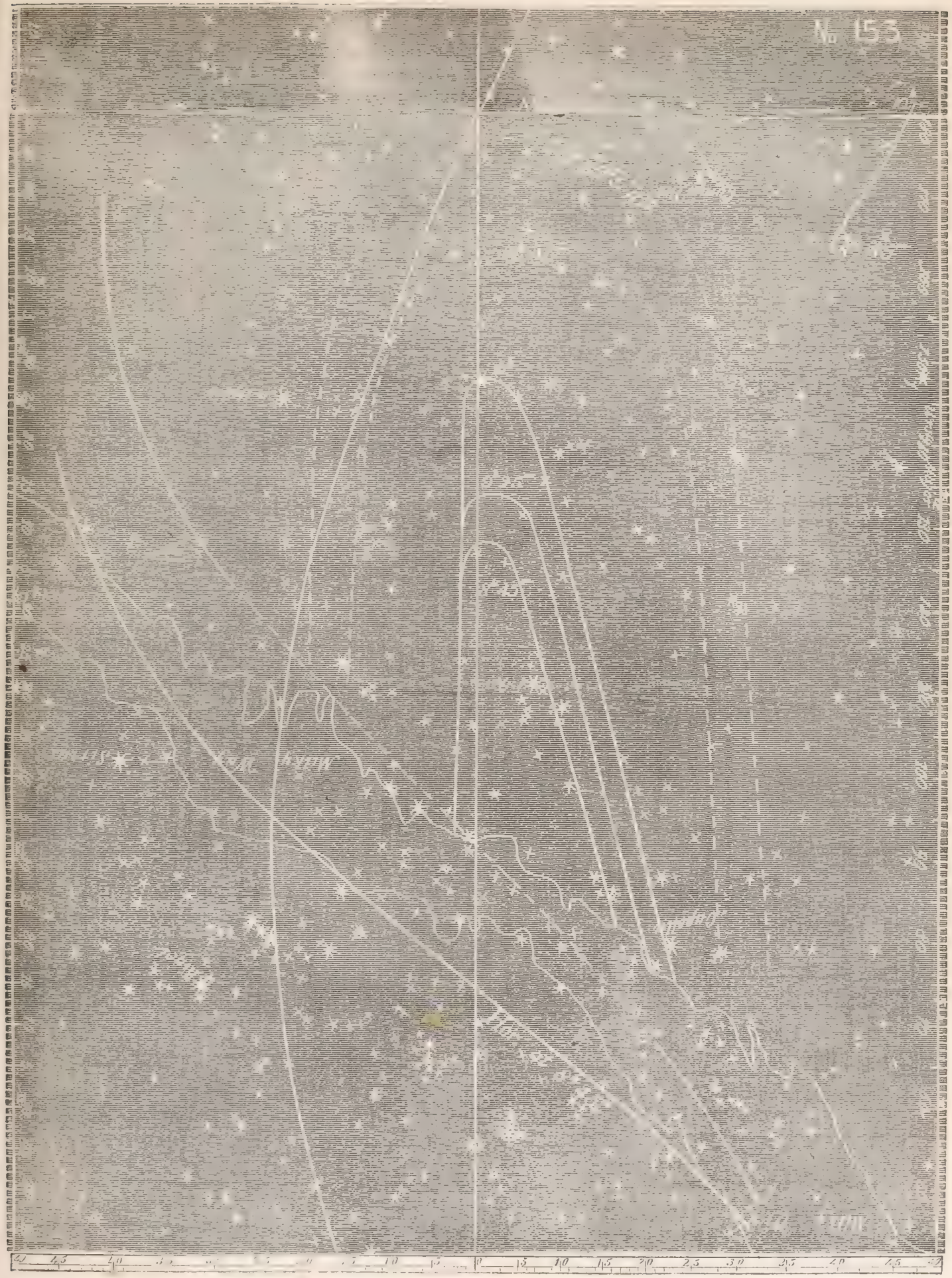
No. 153.

MAY 16th, 1854 : EVENING.

Lat. at 8*h*. 45*m*. 41° 50′ N.: Lon. 141° 8′ E.
Sun set 7*h*. 8*m*.

Stronger Light { 8*h*. 45*m*. / 9 25 / 10 0 } Diffuse 8*h*. 45*m*. and 9*h*. 25*m*.

There is, now, a constant haziness in the sky, much like that of our Indian summer; and observations are, consequently, not as satisfactory as formerly. The Zodiacal Light itself is fully distinct; but there is some difficulty in getting boundaries accurately. I do the best I can. At 10 o'clock, I thought the Stronger Light showed itself up to Regulus; but I do not give this as a certainty. The Diffuse Light is still more ill defined than the other; but I put it down as it appears to me to be.


No 153

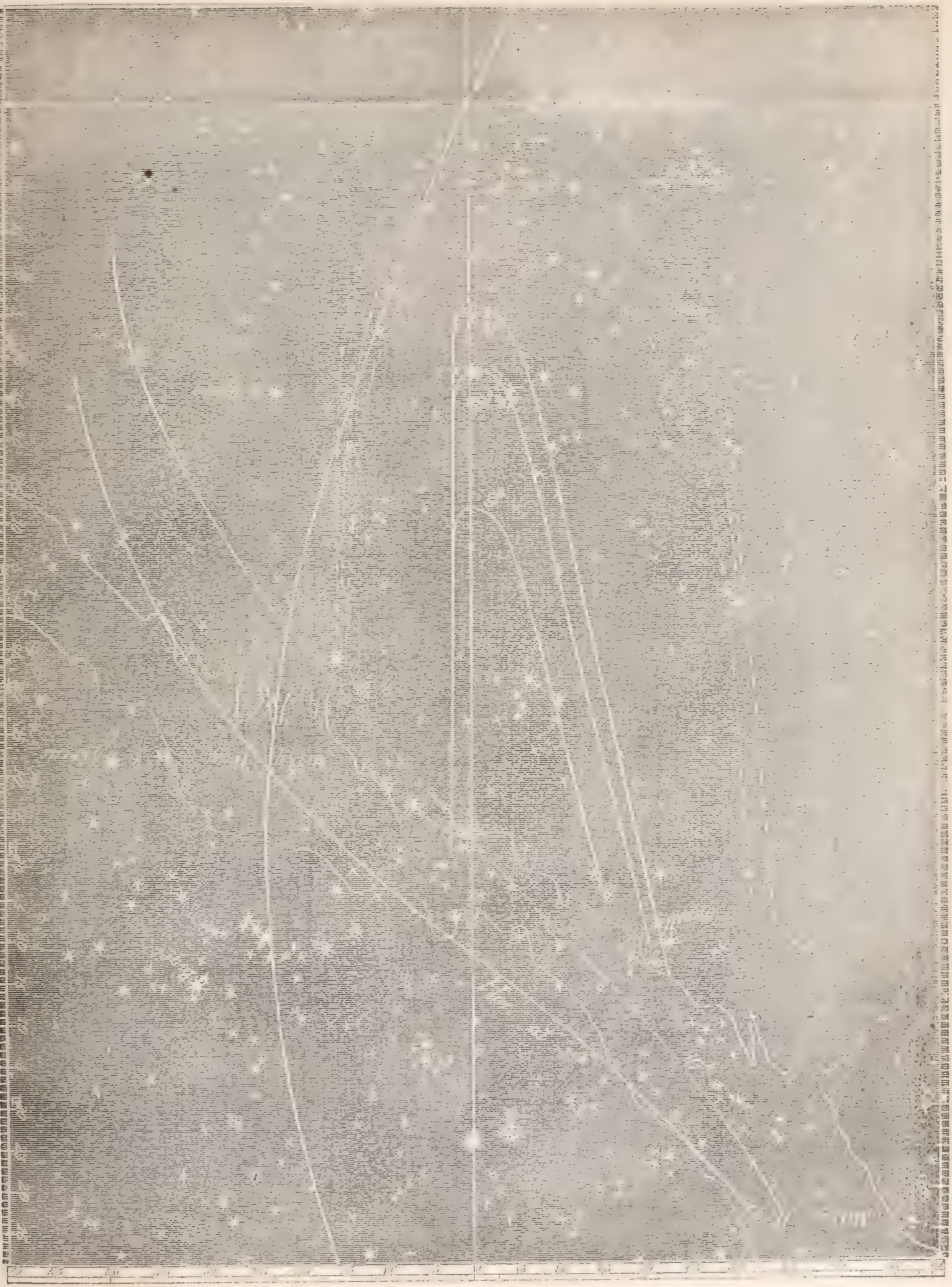
No. 154.

MAY 17th, 1854: Evening.

Lat. 41° 47′ N.: Lon. 140° 43′ E.
Sun set 7*h*. 9*m*.

Stronger and Diffuse Light	9*h*.	0*m*.
	9	30
	10	0

Sky the same as last night. For the results, as accurately as I could get them, see the chart. The sudden ascent of the Stronger Light between 9ʰ and 9ʰ 30ᵐ, as there given, was owing to a greater clearness of the atmosphere at the latter time, which was continued also at 10 o'clock. At 10ʰ 40ᵐ, the haziness had spread once more, and nothing of the Zodiacal Light was then to be seen. The sky, at 9ʰ 30ᵐ and 10ʰ, was nearly or quite free from haze.

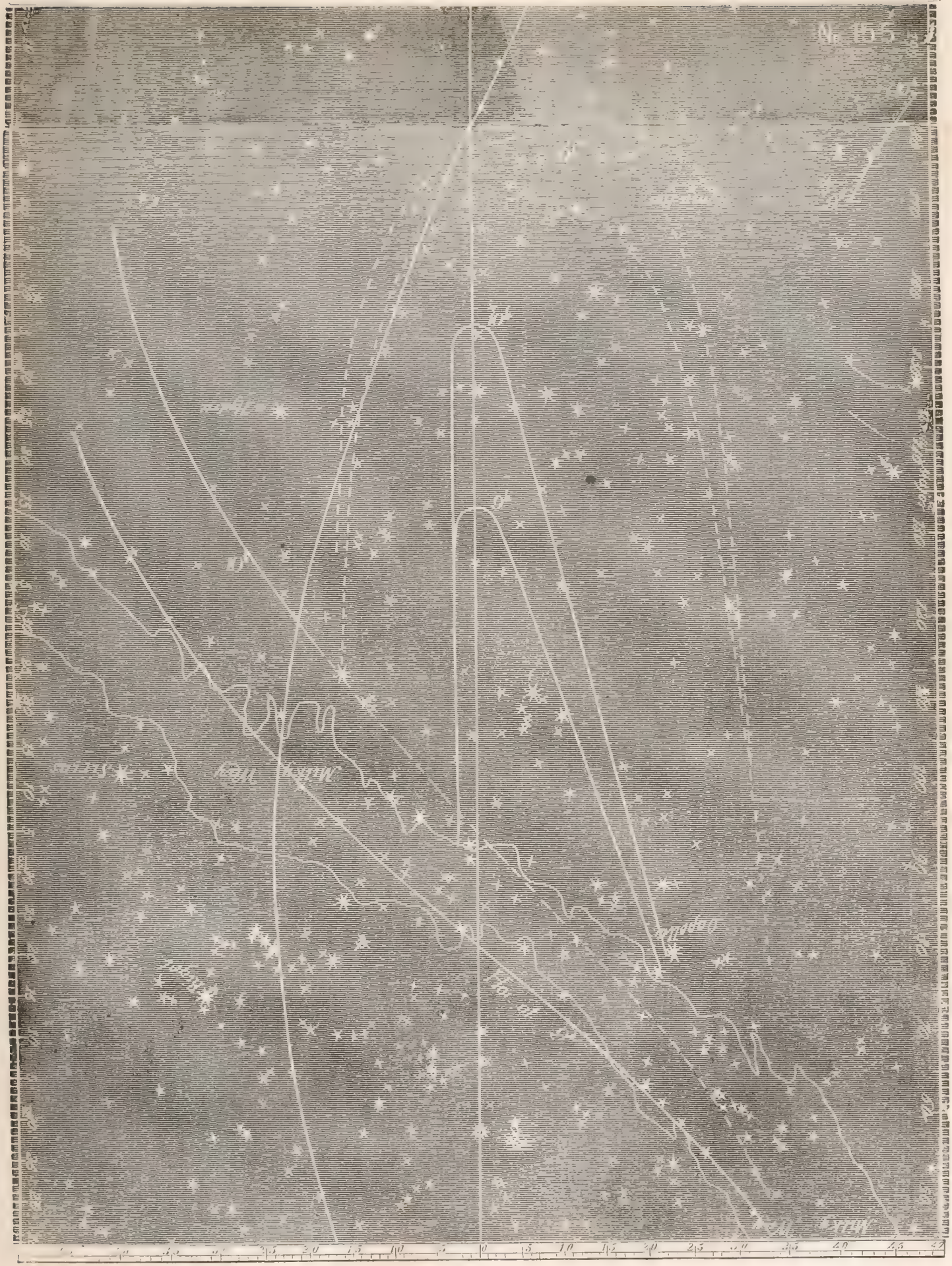


No. 155.

MAY 19th, 1854: Evening.

Lat. 41° 47′ N.: Lon. 140° 43′ E.
Sun set 7*h*. 11*m*.
Stronger and Diffuse Light at 9 and 10 o'clock.

Clouds last evening. This evening cloudless, but still a haziness in the sky. At $8^h\ 45^m$, could see the Zodiacal Light distinctly; but I could not get boundaries till 9 o'clock. Even then, the limits both of the Stronger and Diffuse Light were ill defined. At 9ʰ, the Light was pretty strong up as far as Castor and Pollux. At 10^h, it was all very faint, and I had great difficulty in getting boundaries; think, however, that those in the chart for that hour are tolerably reliable. At $10^h\ 30^m$, there was nothing distinguishable.

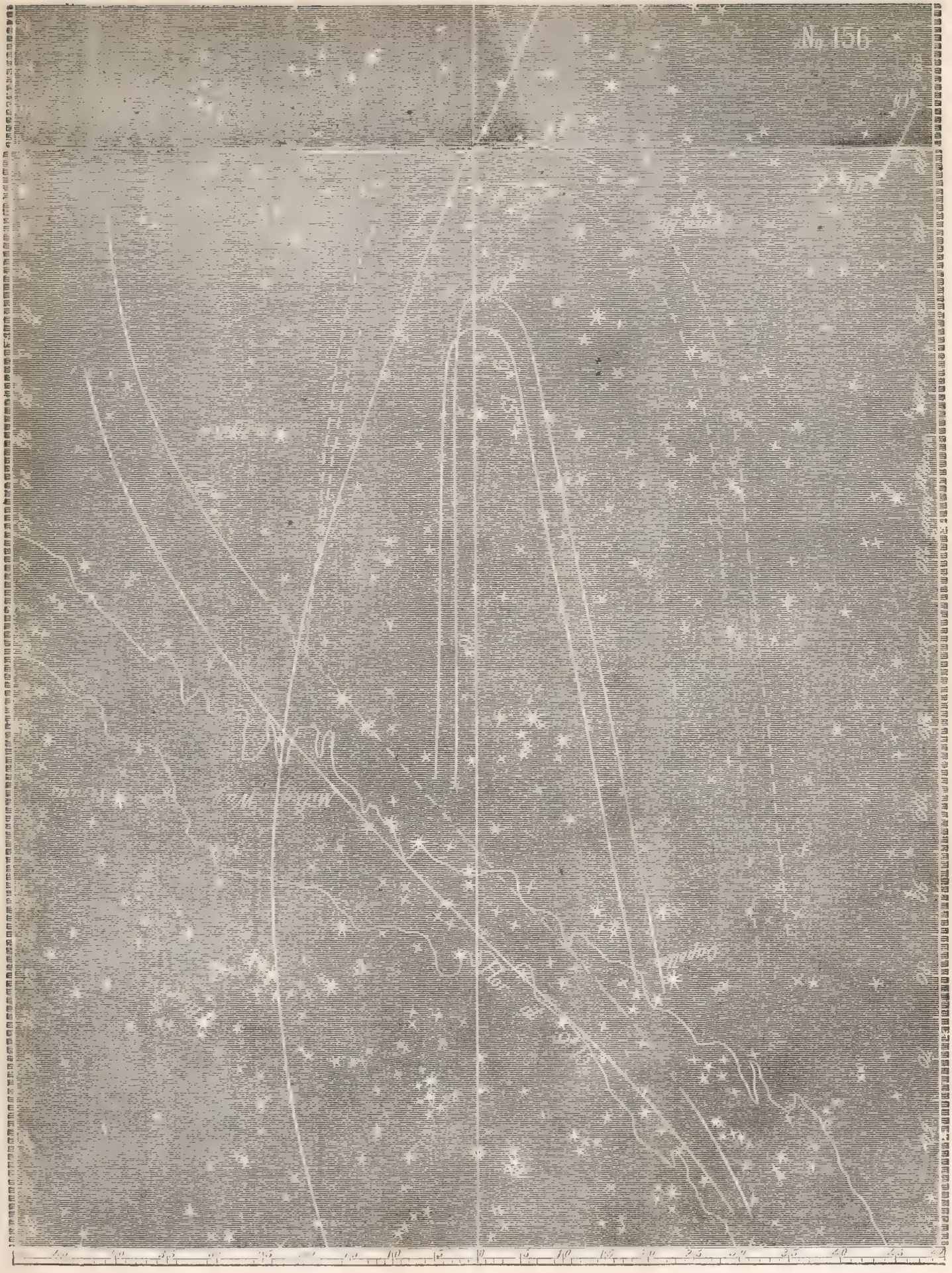

No. 15.

No. 156.

MAY 26th, 1854: Evening.

Lat. 41° 47′ N: Lon. 140° 43′ E.
Sun set 7*h*. 13*m*
Stronger Light at 9*h*. 15*m*. and 10*h*.: Diffuse 9*h*. 2 *m*. and 10*h*.

Sky hazy as usual. Could not get any reliable outlines until 9^{h} 15^{m}. The Zodiacal Light itself was very decided, and was tolerably strong up to 16 Cancri; but there was difficulty in making out the outlines. At 10^{h}, the sky was tolerably clear; and the Light was very distinct yet, at 10^{h} 15^{m}; though the difficulty of getting boundaries still remained.


No. 156

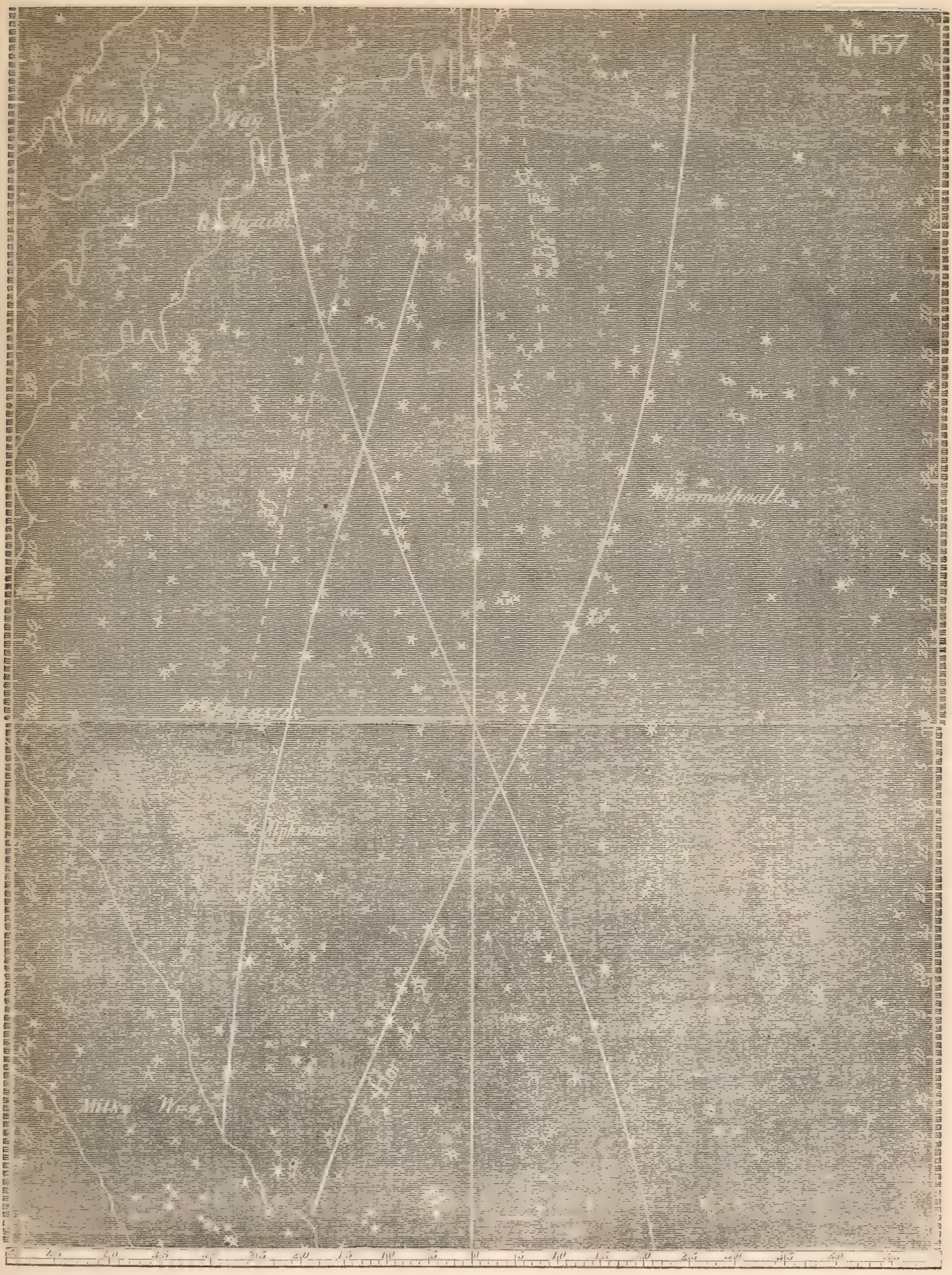
No. 157.

MAY 22d, 1854 (21st was Sunday): MORNING.

Lat. 41° 47′ N: Lon. 140° 43′ E.
Sun rose 4*h*. 38*m*.
Stronger and Diffuse Light at 2*h*. 30*m*.
Zenith point at 2*h*. 30*m*.: Lat. 0.5° N.: Lon. 286°.

Owing to the clouds and moon, this was the first morning observation which I have been able to have in a long while. The sky, on this occasion, was pretty free from the haziness with which it is now usually obscured. At 2^h 30^m, the Zodiacal Light was very distinct, and its boundaries were easily got, except the lower part of the Diffuse Light. In getting the upper extremity of the Stronger Light, I was troubled by the great brightness of Jupiter, now at that spot; but I put it down in the chart as it seemed to me to be.

Moon rose at 2^h 45^m.

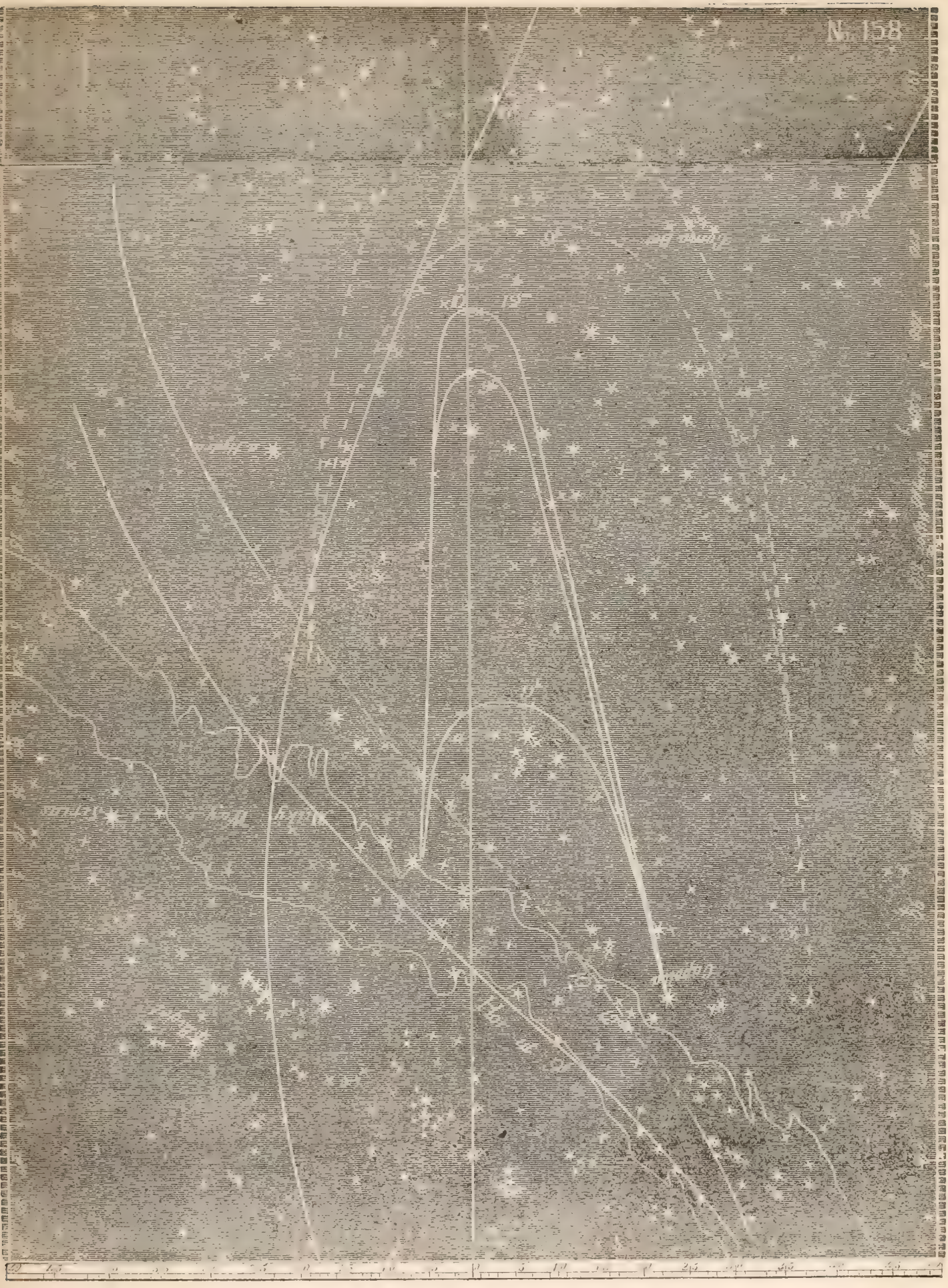

N. 157

No. 158.

MAY 22d, 1854: Evening.

Lat. 41° 47′ N.: Lon. 140° 43′ E.
Sun set 7*h*. 14½*m*.
Stronger and Diffuse Light at 10*h*. 12*m*.

Sky pretty clear from haziness at 9^h, except towards the horizon; quite clear in the zenith. A change in the appearance of the Stronger Light, which I have alluded to in recent entries, leads me now to make a slight change in the mode of mapping. This Light is quite strong within the boundary *a a* (see chart)—as strong as the Stronger Light has usually been. Above that, although evidently a continuation of the same light, it is so dimmed that it can scarcely be recognized as a continuation of that Stronger Light; and I have thus given two full lines for that hour (9 o'clock). At 10^h 12^m, the Light was very dim; but I thought I could make out its boundaries as in the chart.


N. 158

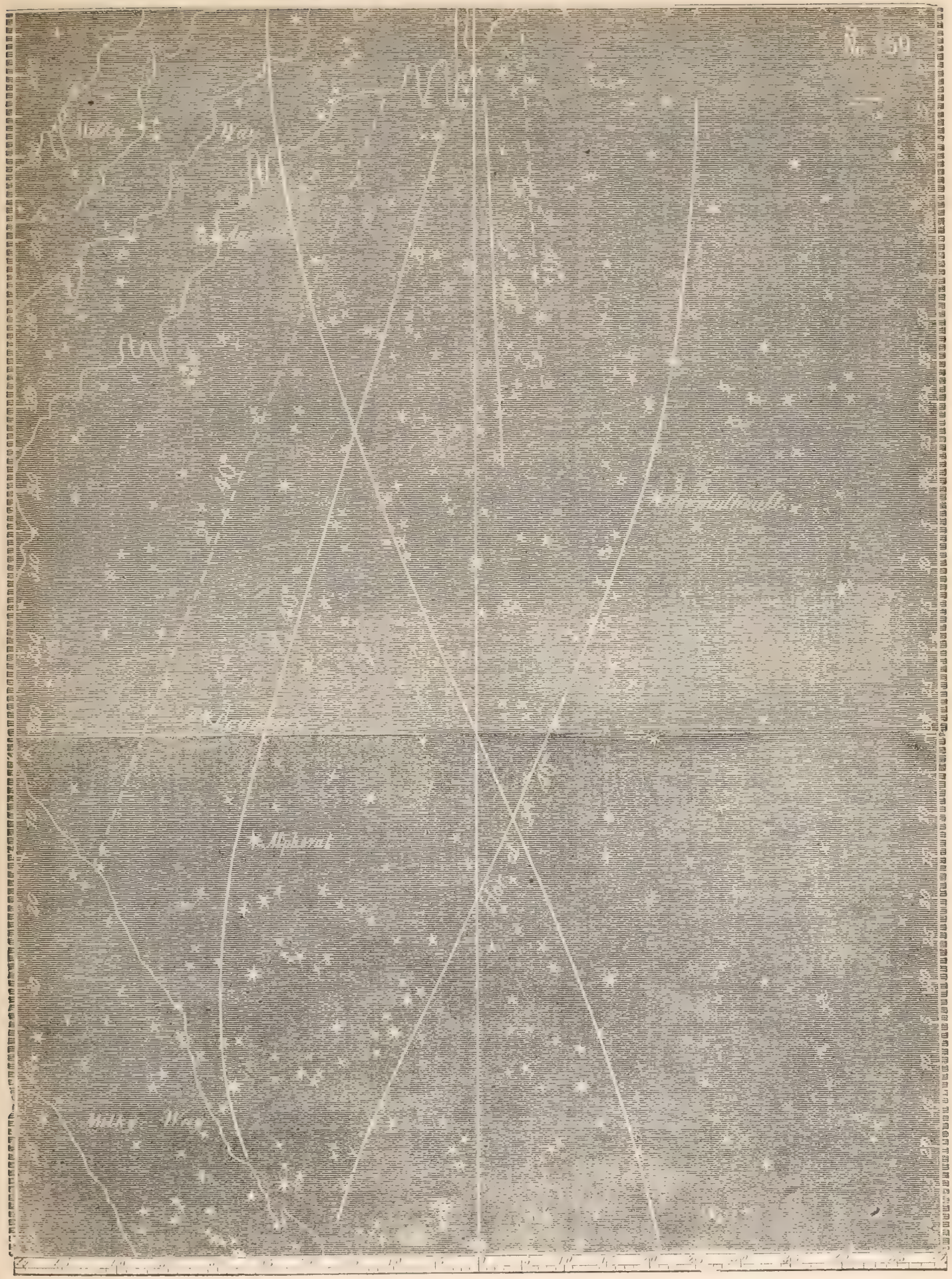
No. 159.

MAY 23d, 1854: MORNING.

Lat. 41° 47′ N.: Lon. 140° 43′ E.
Sun rose 4*h*. 37½*m*.
Stronger and Diffuse Light at 2*h*. 40*m*
Zenith point at 2*h*. 40*m*.: Lat. 64° 25′ N.: Lon. 293°.

The sky was hazy on the horizon; but the haziness diminished as it ascended, and, at 25° of altitude, was scarcely perceived. In the zenith, the sky was clear and bright. The Zodiacal Light was very evident, and its boundaries pretty well defined, except the lower one of the Diffuse Light. I thought, yesterday morning, that the Stronger Light rounded off in the neighborhood of Jupiter; but this morning it appeared to extend nearly or quite to the Milky Way, and I have left its end undefined.

Dawn a few minutes after 3 o'clock.

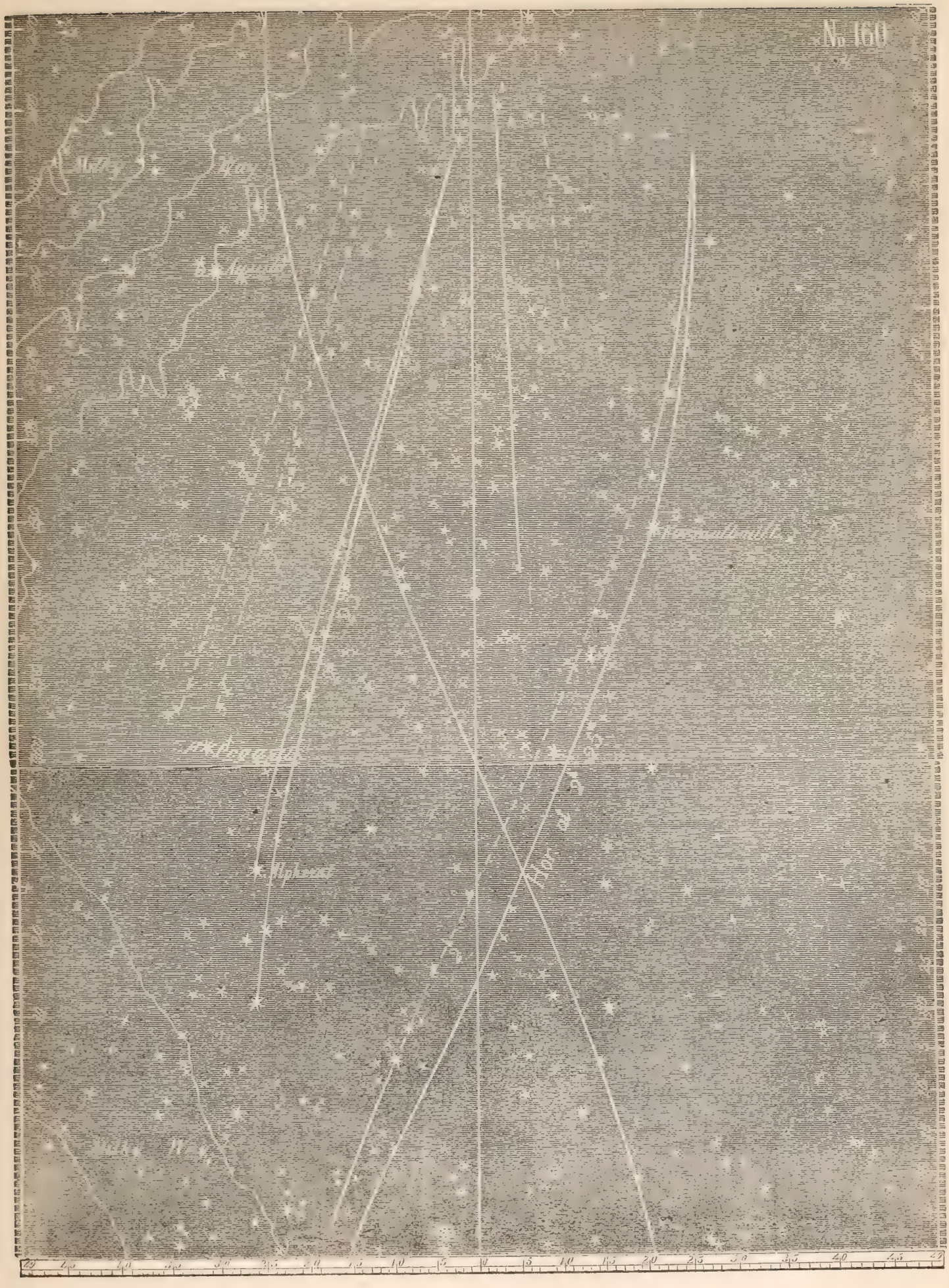

No. 59

No. 160.

MAY 29th. 1854: Morning.

Lat. 41° 47′ N.: Lon. 44° 43′ E.
Sun rose 4*h*. 34*m*.
Stronger and Diffuse Light at 2*h*. and 2*h*. 25*m*.
Zenith point at 2*h*: Lat. 65° 5′ N.: Lon. 289°.

Clouds uniformly since last date till this morning. Rose a little before 2 o'clock, and found the sky overcast above, and also a stratum of clouds along the horizon, but with an interval between them of clear, bright sky, free from haziness; thus had satisfactory observations. At that early hour the Zodiacal Light was very distinct. As the hour progressed, the ecliptic approached rapidly towards a parallelism with the horizon, and the upper limits of the Zodiacal Light changed downwards, especially on the left. At the same time, the boundaries became less and less clearly marked; and at $2^h\ 30^m$ the Light itself was not as distinct, except at the north or left termination, as at 2^h. At $2^h\ 38^m$ it was difficult to get the boundaries at all, and at $2^h\ 45^m$ they were quite gone. Clouds then spread over the space, and my observations ceased.

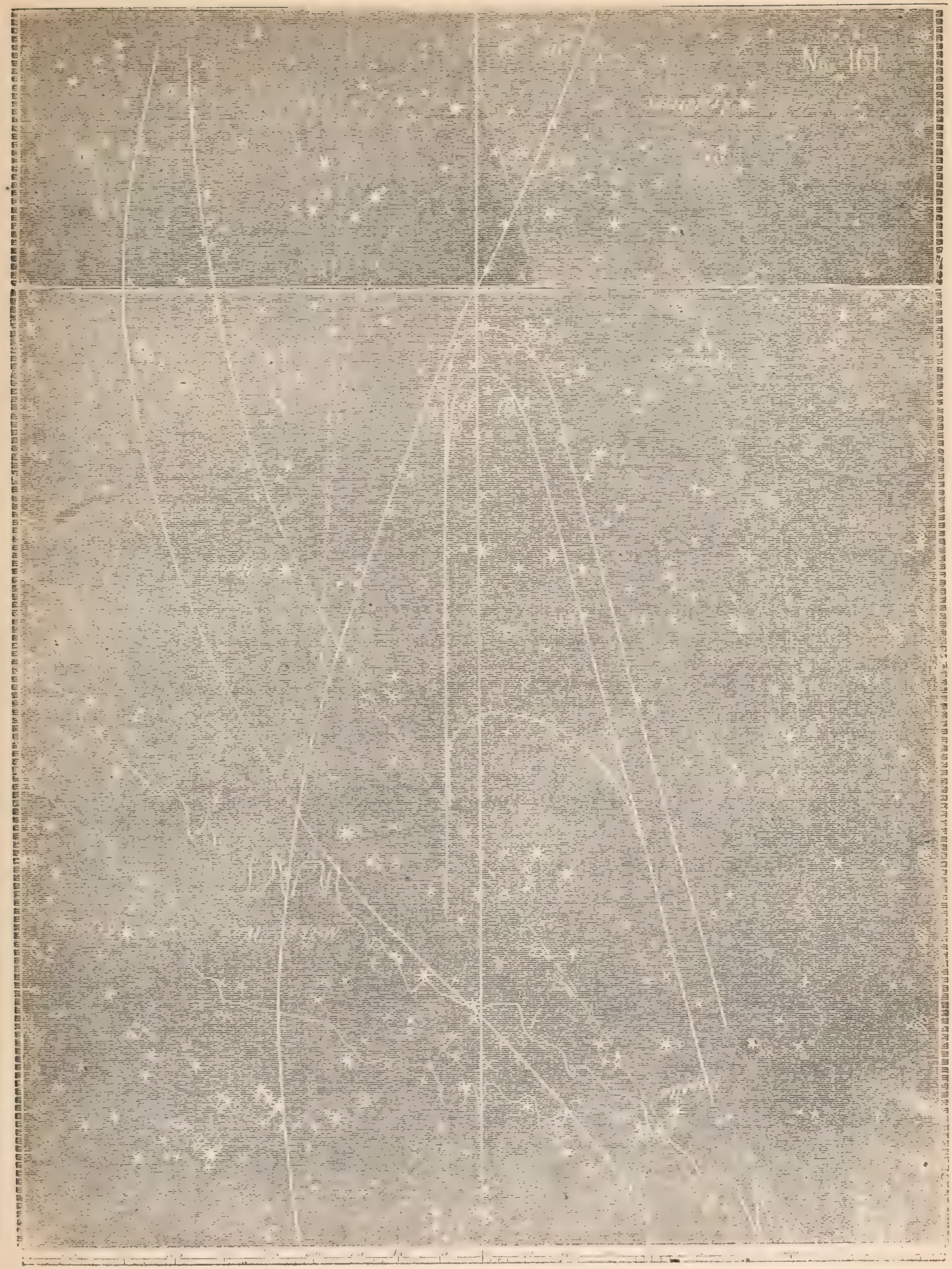

No 160

No. 161.

MAY 29th, 1854: Evening.

Lat. 41° 47′ N.: Lon. 140° 43° E.
Sun set 7*h*. 19*m*.
Stronger and Diffuse Light at 9*h*. 10*m*. and 10*h*. 30*m*.

About 9^h 10^m the moon sunk behind some clouds near the horizon, and I was able to get an observation. The sky was very clear; but the evening Zodiacal Light, though very distinct, has now lost much of its brightness, our latitude being high, and the ecliptic having a low angle with the horizon. The brightest part was below the zigzag line, but still the Stronger Light could be traced up, as given in the chart. At 10^h 30^m the Light could still be made out, though it was dim. The Diffuse Light was now particularly faint—scarcely perceptible. I have given the outlines as they appeared to be. At 11^h 20^m there seemed to be something of it left; but I could not be certain.

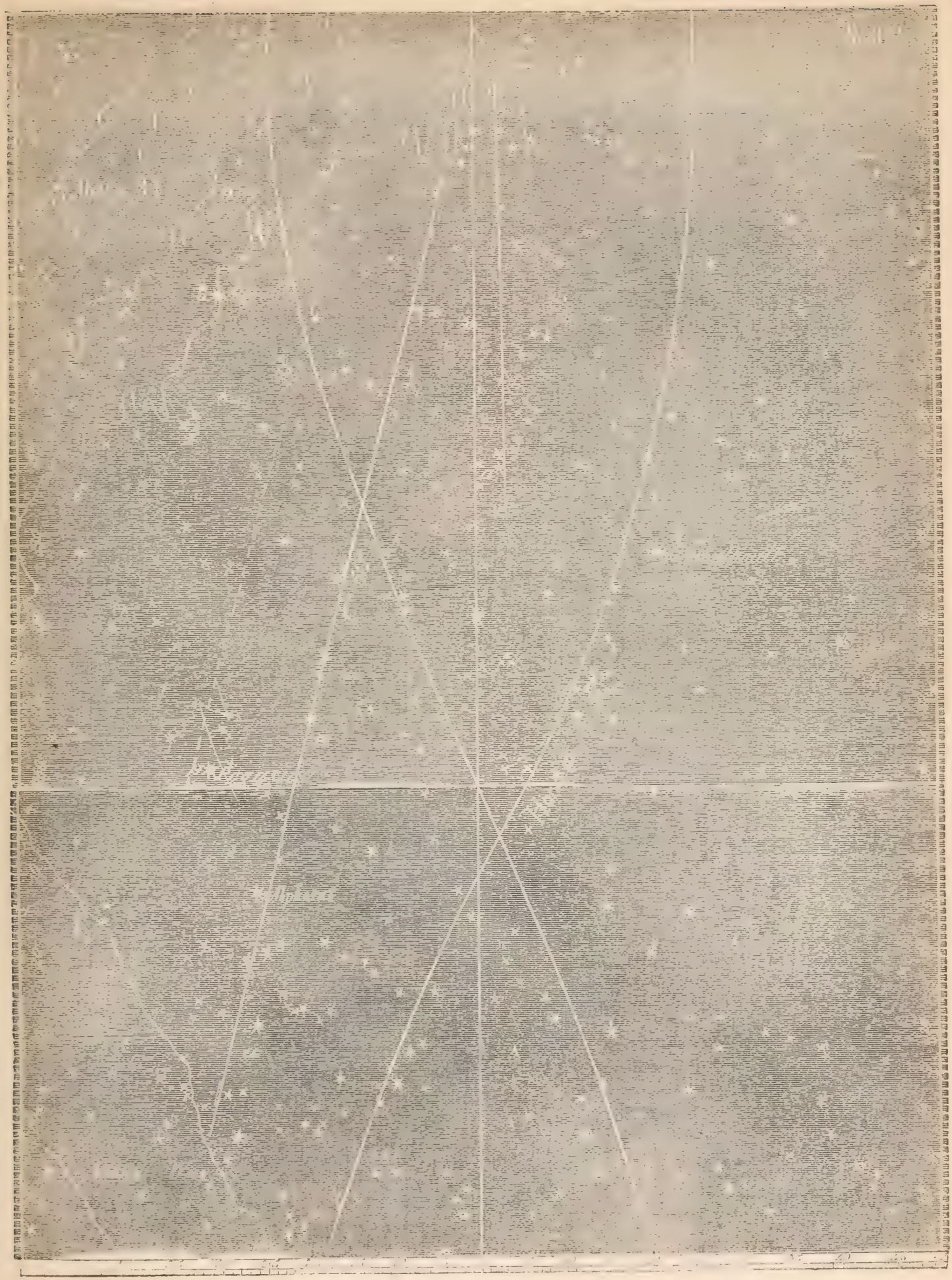


No. 162.

MAY 30th, 1854: Morning.

Lat. 41° 47′ N: Lon. 140° 43′ E.
Sun rose 4*h*. 33*m*.
Stronger and Diffuse Light at 1*h*. 50*m*.
Zenith point at 4*h*. 33*m*: Lat. 65° 15′ N: Lon. 2·5°.

At 1ʰ 45ᵐ the Zodiacal Light distinct, but faint. The sky clear and good for observing; but Jupiter's light embarrasses the observer, and prevents certain limits being got at the upper end. The Light was stronger within the limits *a a a a;* at 2ʰ 20ᵐ, it brightened considerably at its lower end, especially with *a a a a*. At 2ʰ 45ᵐ a cloud came over, and put an end to observation.



No. 163.

JUNE 2d, 1854: Morning.

Lat. 41° 47′ N.: Lon. 146° 43′ E.

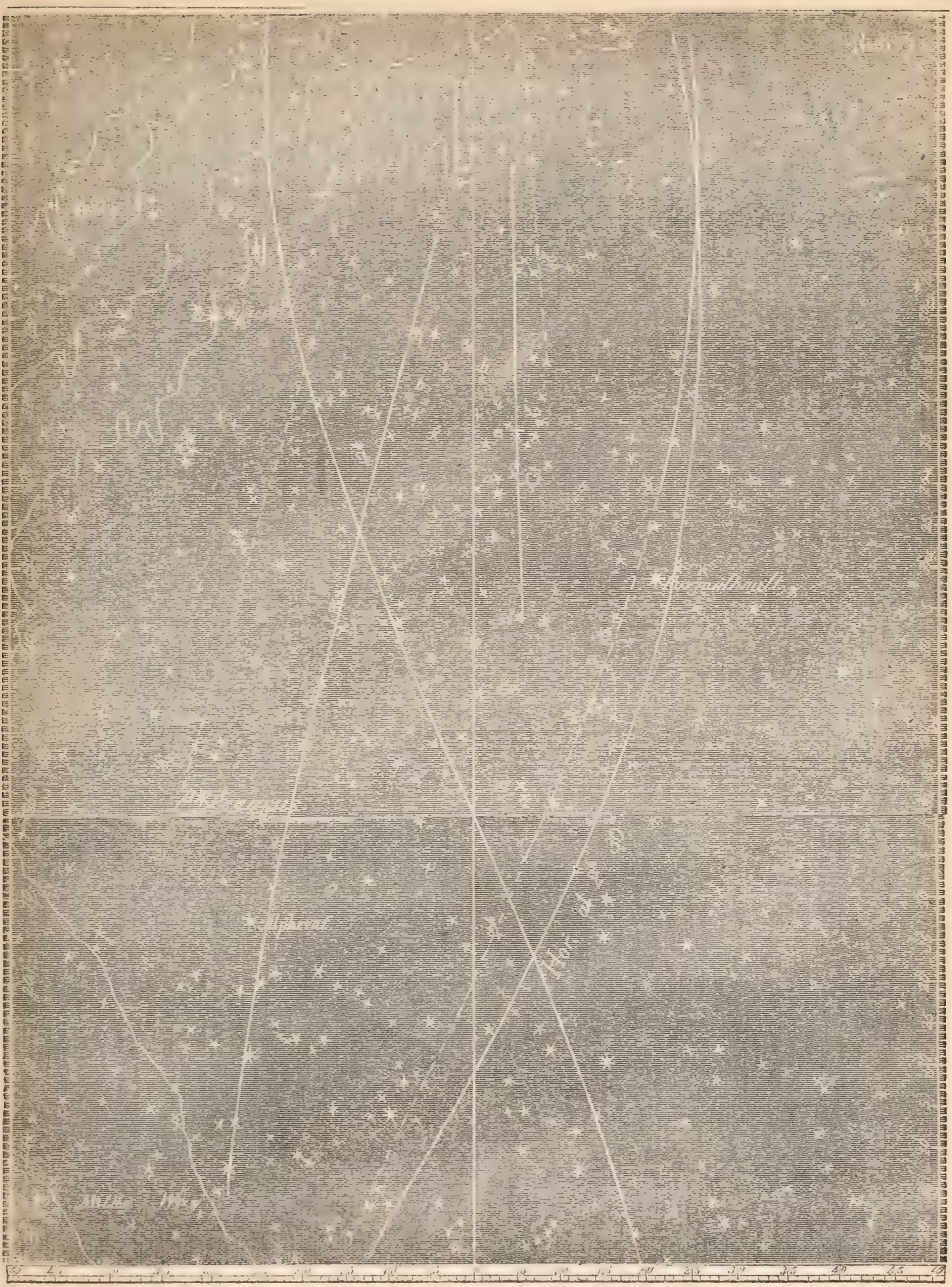
Sun rose 4*h*. 31½*m*.

Stronger Light at { 2*h*. 0*m*. / 2 30 } Diffuse at 2*h*.

Zenith point at 2*h*. 30*m*.: Lat. 63° 10′ N.: Lon. 303°

Fogs or clouds since the 30th ultimo. Was on deck this morning at 1^h 50^m, and found the sky very clear, and the Zodiacal Light distinct, though dim. At 2^h got boundaries, as in the chart; the lower boundary of the Diffuse, however, not fully reliable, but given as it appeared to be. At 2^h 30^m the Light had increased considerably in brightness, especially at its lower end, and up to the boundary *a a*. At 2^h 38^m still brighter, and the greatest brightness up to the boundary *b b*. At 2^h 50^m a general whiteness in the sky, and could not get boundaries any longer.

At 2^h the boundary of the Stronger Light, on the lower side, could be made out to *c*; at 2^h 30^m it had extended to *d*.

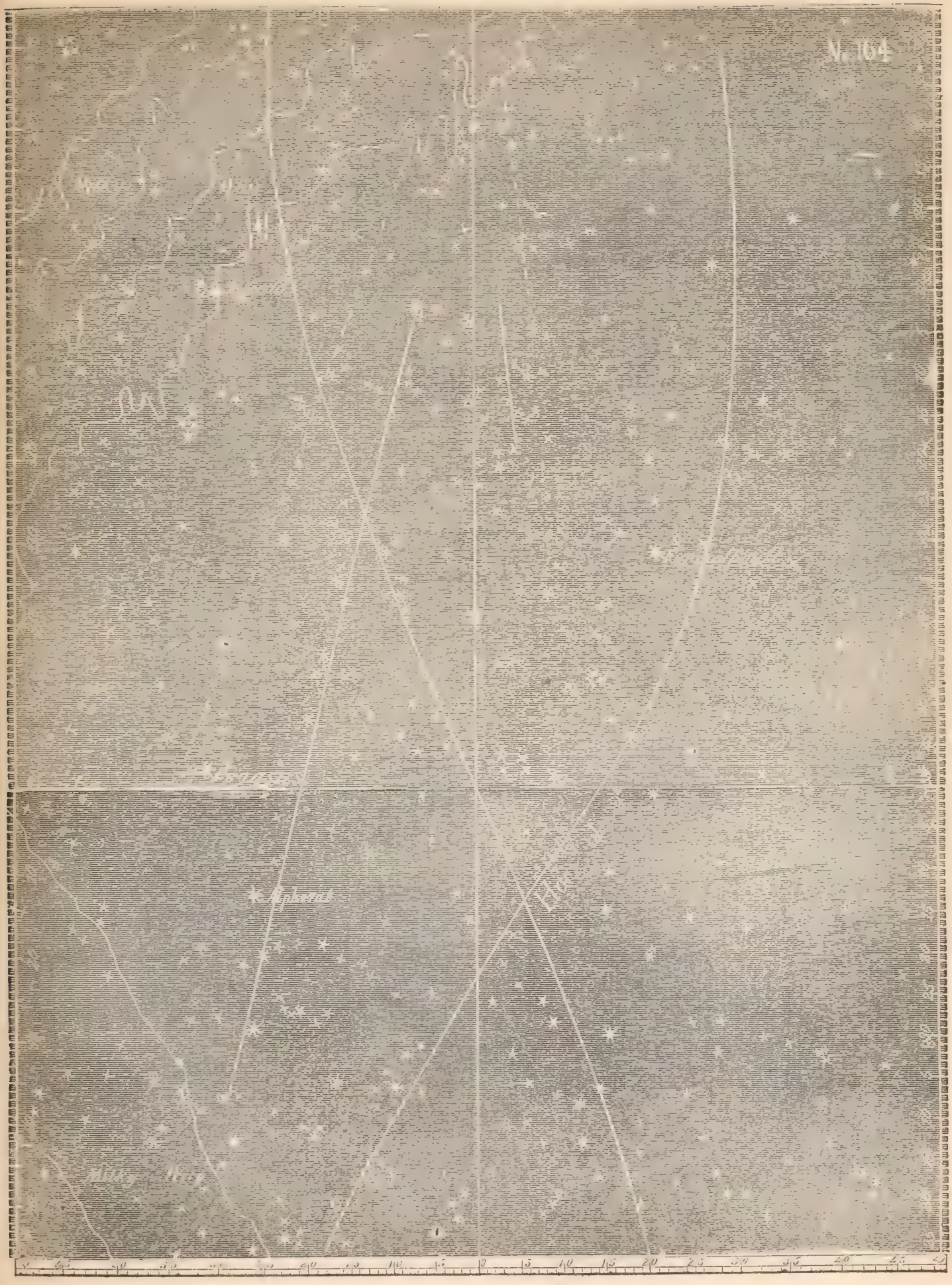


No. 164.

JUNE 5th, 1854: MORNING.

Lat 37° 34′ N: Lon 141° 59½′ E.
Sun rose 4*h* 41*m*
Stronger and Diffuse Light at 2 o'clock.
Zenith Point at 2*h*: Lat 39° 5′ N.: Lon 214°.

Fogs, &c., since my last. Found on going on deck, at 2, a. m., that the change of a few degrees in our latitude had sensibly lifted up the Zodiacal Light, and had made it much more striking and decided than at my last observation. To this, the change in the atmosphere had doubtless, also, contributed in some measure: for the sky this morning was remarkably brilliant. At first sight, and repeatedly afterwards, I thought the Stronger Light terminated at α and β Capricorni; but of this could not be certain, on account of the glare of Jupiter. Sometimes thought it continued on to the Milky Way; and I have marked both sides in the chart with dotted lines. Soon after 2*h*, clouds came up and stopped observations.


N. 164

No. 165.

JUNE 8th, 1854: Morning.

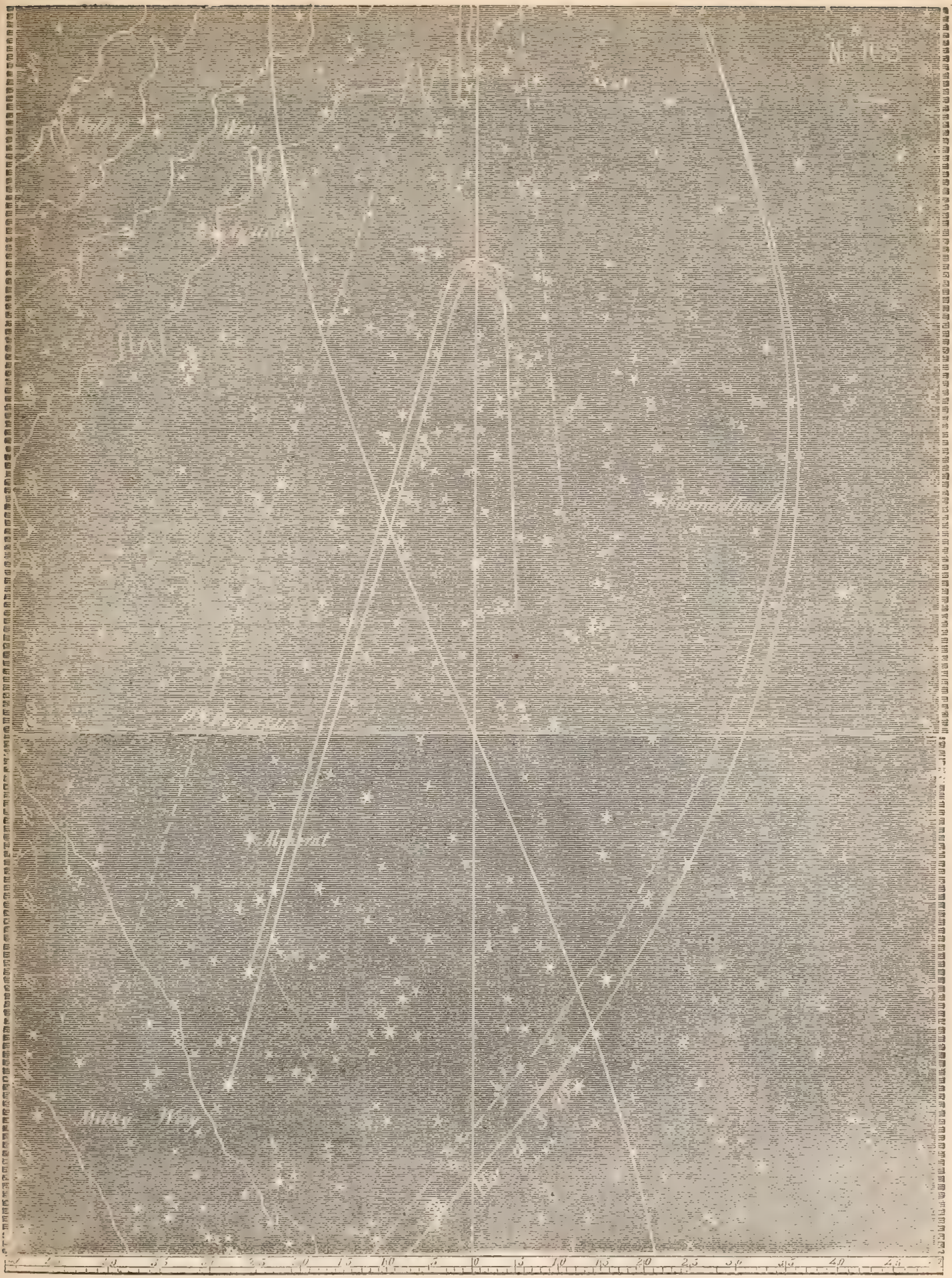
Lat. 34° 39′ N: Lon. 138° 33′ E.

Sun rose $4h\ 51m$.

Stronger Light at $\left\{\begin{matrix}3h.\ 0m. \\ 3\ \ 20\end{matrix}\right\}$ Diffuse, $3h$.

Zenith point at $3h$.: Lat. 51° 30′ N.: Lon. 323°.

Clouds until near 3 o'clock, when I had a very clear, bright sky, excellent for observation. The Zodiacal Light was very distinct, the change of latitude now making it ascend much higher in the sky than has lately been the case. Got observations at 3 o'clock, and at $3^h\ 20^m$ for the Stronger Light: the lower boundary of the Diffuse was not very distinct at any time. Dawn at about $3^h\ 28^m$. This comes now slowly, and by imperceptible degrees.



No. 166.

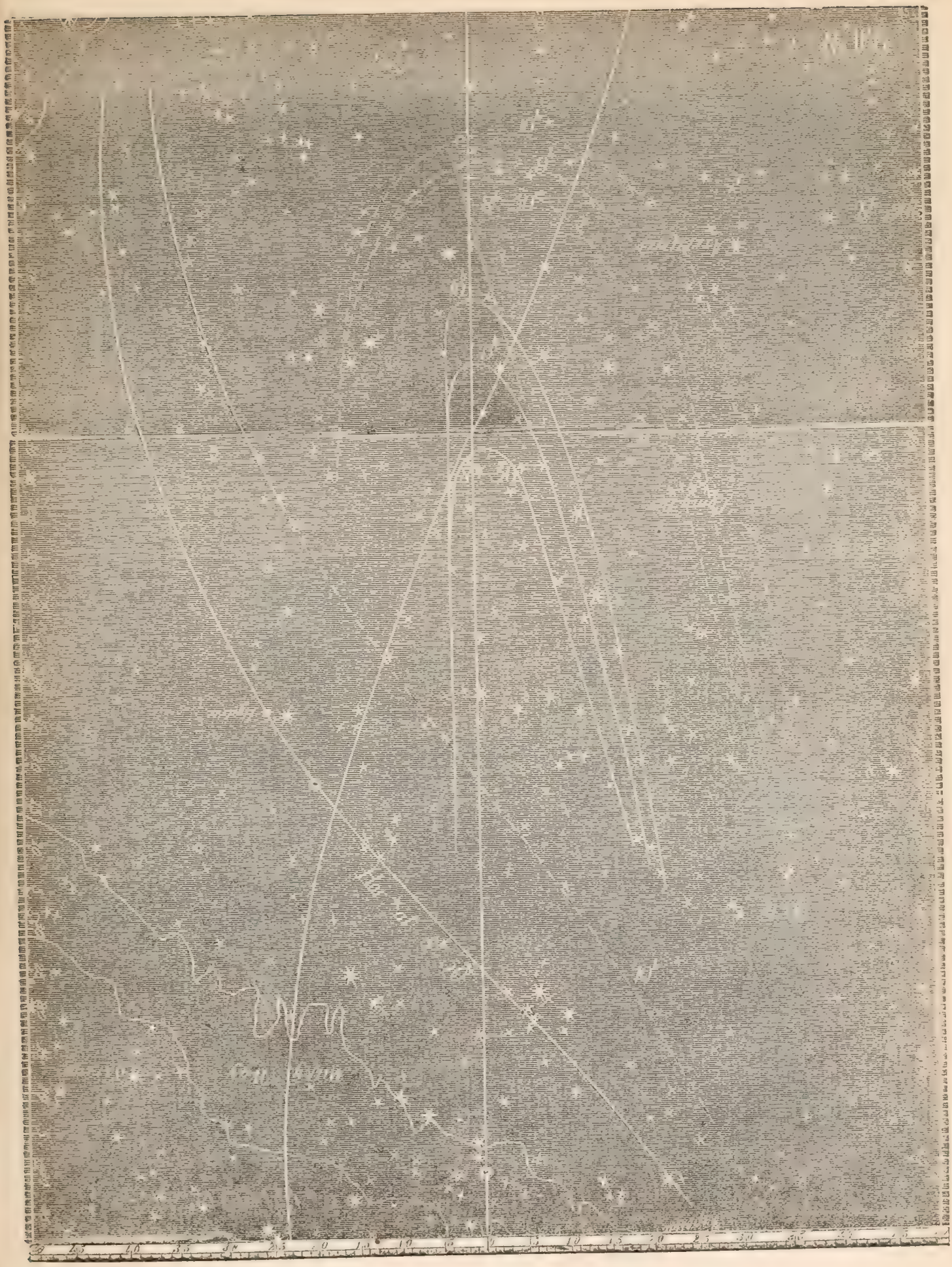
JUNE 21st, 1854: Evening.

Lat. 34° 39′ N.: Lon. 138° 59′ E.

Sun set 7*h*. 11*m*.

Stronger and Diffuse Light at { 8*h*. 50*m*. / 9 0 / 10 0

Clouds ever since last date, until this evening, when the sky was very favorable for observations. Owing to the long twilight, however, I could not get boundaries until 8ʰ 50ᵐ; at 9 o'clock the darkness had increased, and wider boundaries were, consequently, visible. At 10ʰ the Light had still considerable brightness; but the ecliptic had sunk so much towards the horizon that it was difficult to get reliable boundaries: I believe, however, that those given may be depended on.

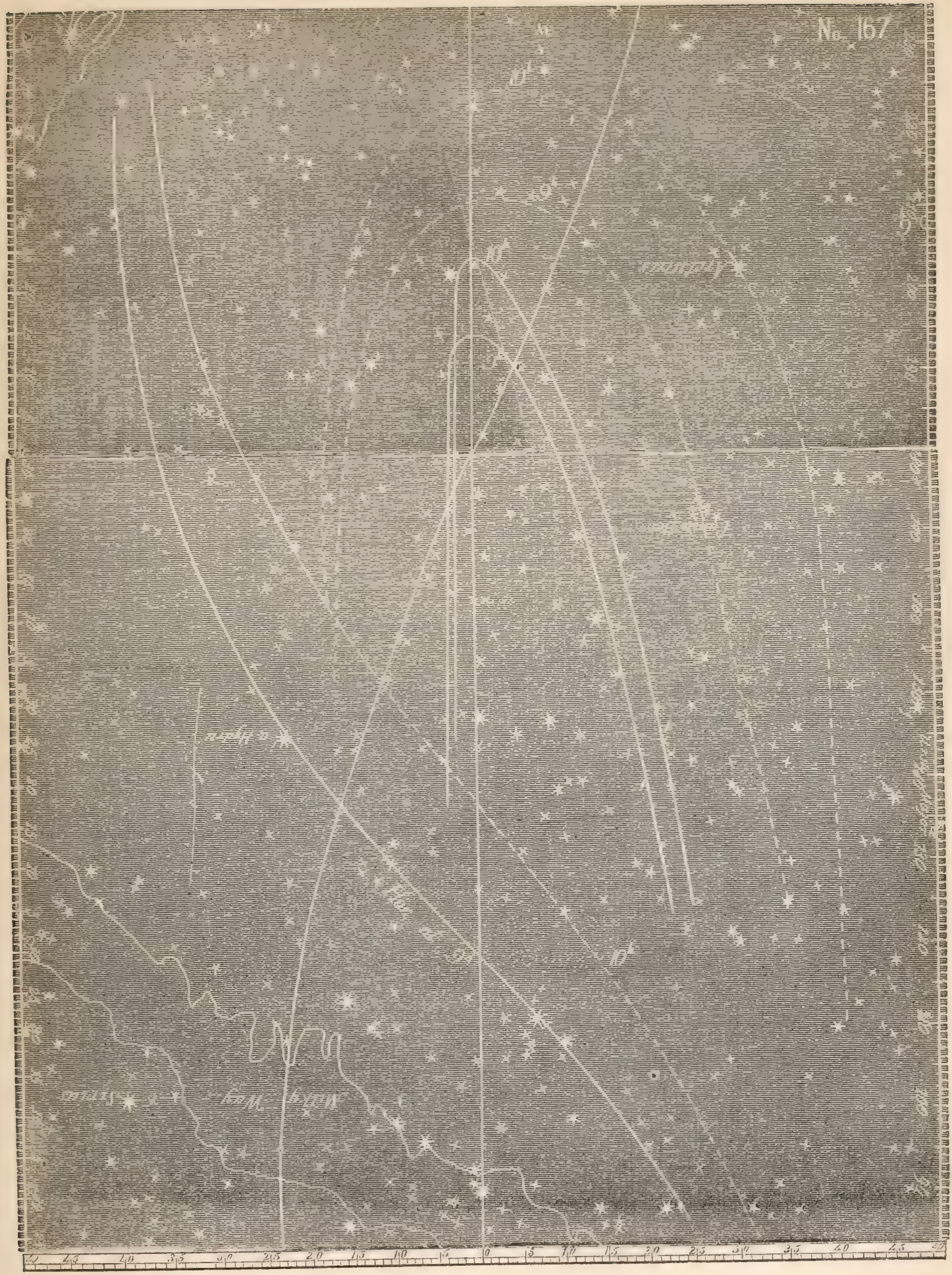


No. 167.

JUNE 22d, 1854: Evening.

Lat. 34° 4′ N.: Lon. 13° 59′ E.
Sun set 7*h*. 11½*m*.
Stronger and Diffuse Light at 9 and 10 o'clock.

Sky clear, and good for observations. Boundaries distinct at 9 o'clock; at 9^h 30^m could not perceive any difference in them: at 10^h, as in the chart; the Light then very distinct, and its outlines well defined. at 10^h 40^m the Light still very decided, but could get no reliable boundaries.

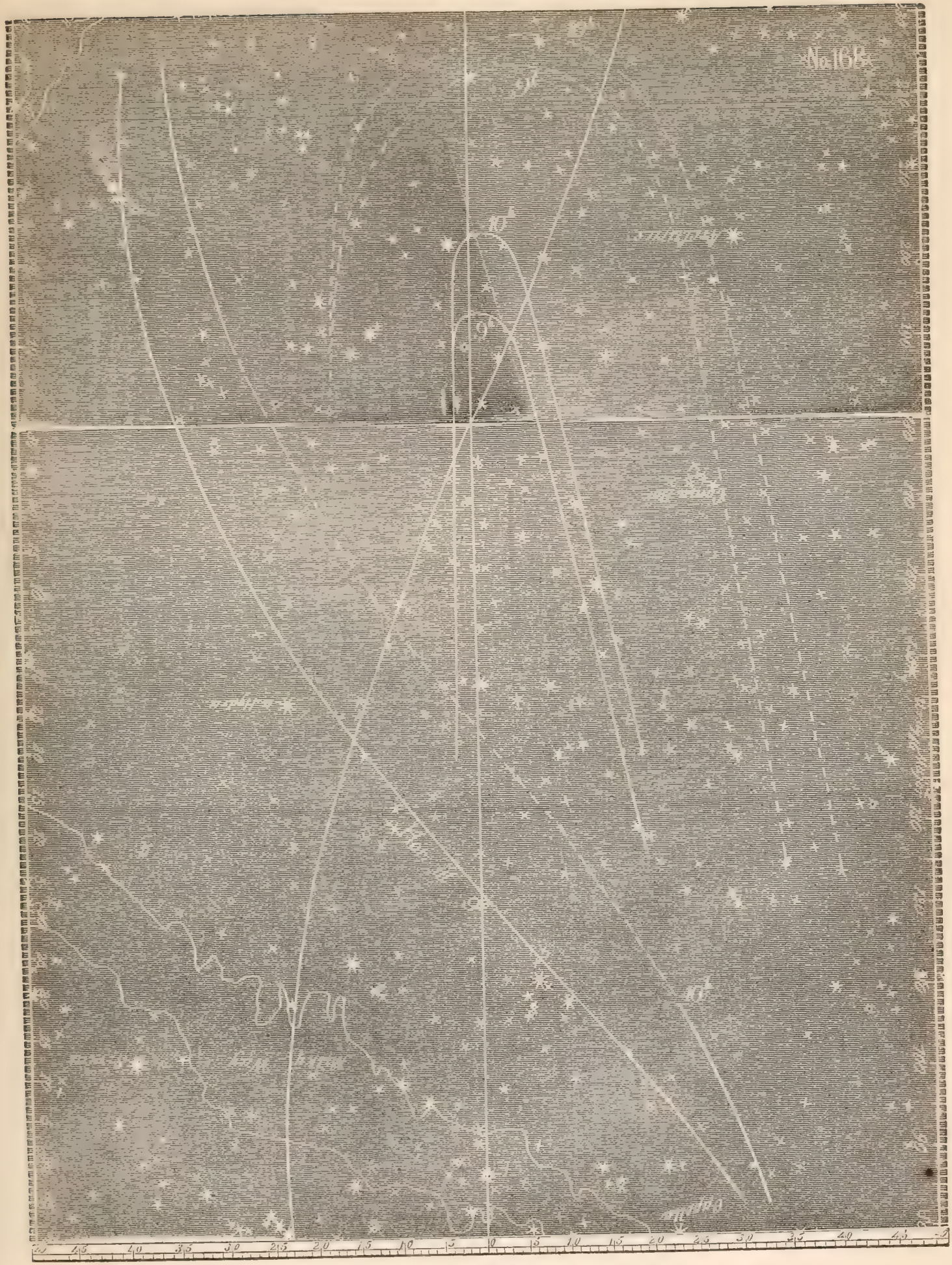

No. 167

No. 168.

JUNE 24th, 1854: Evening.

Lat 31° 40′ N.: Lon. 135° 59′ E.
Sun set 7*h*. 12*m*
Stronger and Diffuse Light, 9 and 10 o'clock.

Storming all day; cleared up suddenly; and at 9^h p. m., the sky was remarkably clear and bright—the atmosphere having been purified by the storm. With all this, however, there was some difficulty in getting the boundaries at the upper end of the Stronger Light, and still greater as respects the Diffuse Light throughout. At 10^h the Zodiacal Light was still very decided; but I can scarcely set down the boundaries given to the Diffuse Light, at that hour, as fully reliable, though the sky was still very clear. I give them as they appeared to me to be, without offering them as a certainty.

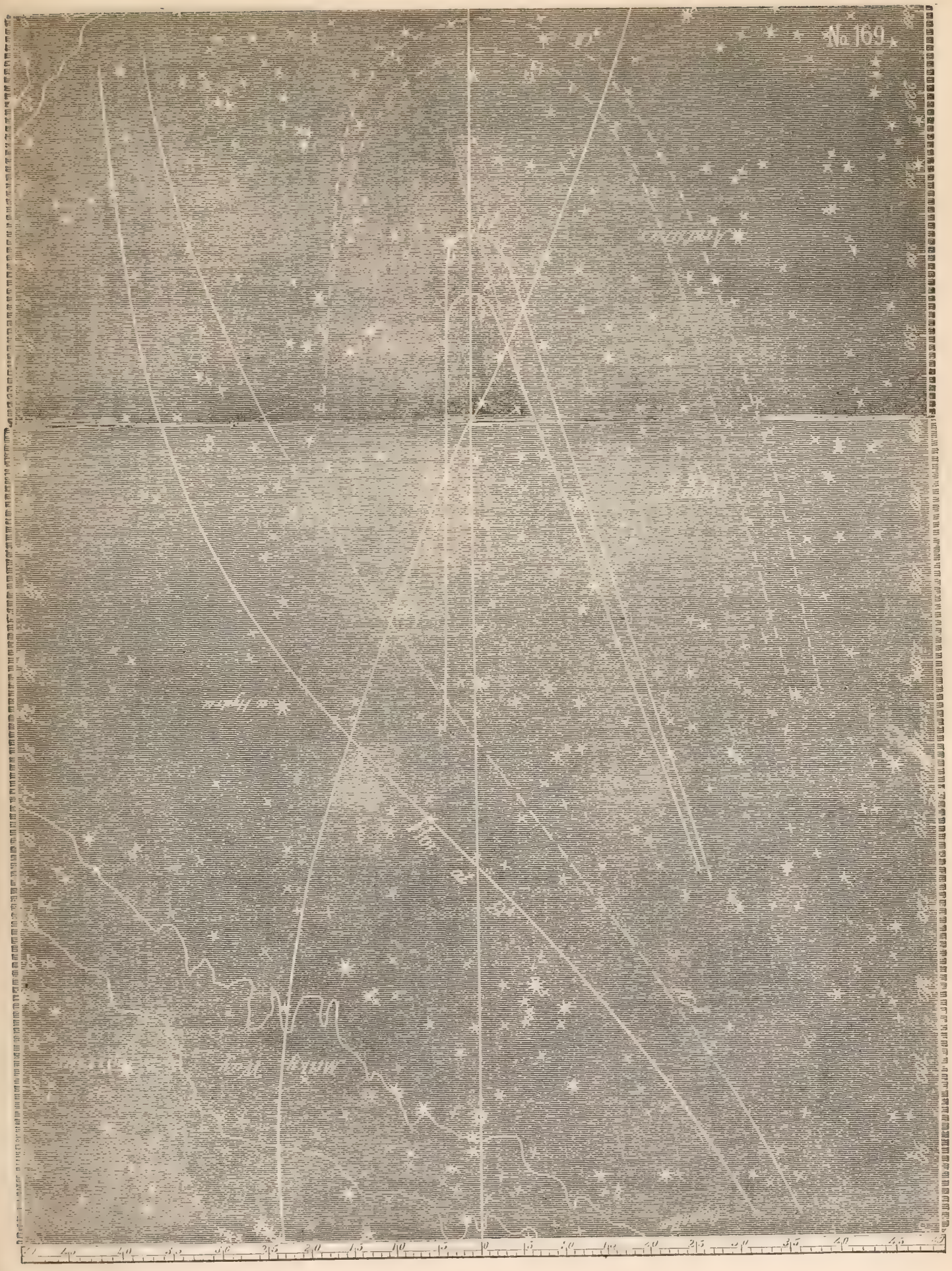

No. 168.

No. 169.

JUNE 27th, 1854: Evening.

Lat. at 9*h*., 33° 1′ N.: Lon. 136° 45′ E.
Sun set 7*h*. 9½*m*.
Stronger and Diffuse Light at 9 and 10 o'clock.
Zenith point at 9*h*.: Lat. 49° N.: Lon. 215°.

Last evening, clouds. Sky remarkably bright and clear, this evening. The Zodiacal Light distinct at $8^h\ 40^m$; but I could not get reliable boundaries till later. At 9^h, as in the chart. At 10^h, sky still very clear, but the Light much dimmed; and it was difficult to make out the boundaries, especially beyond 94 Leonis.

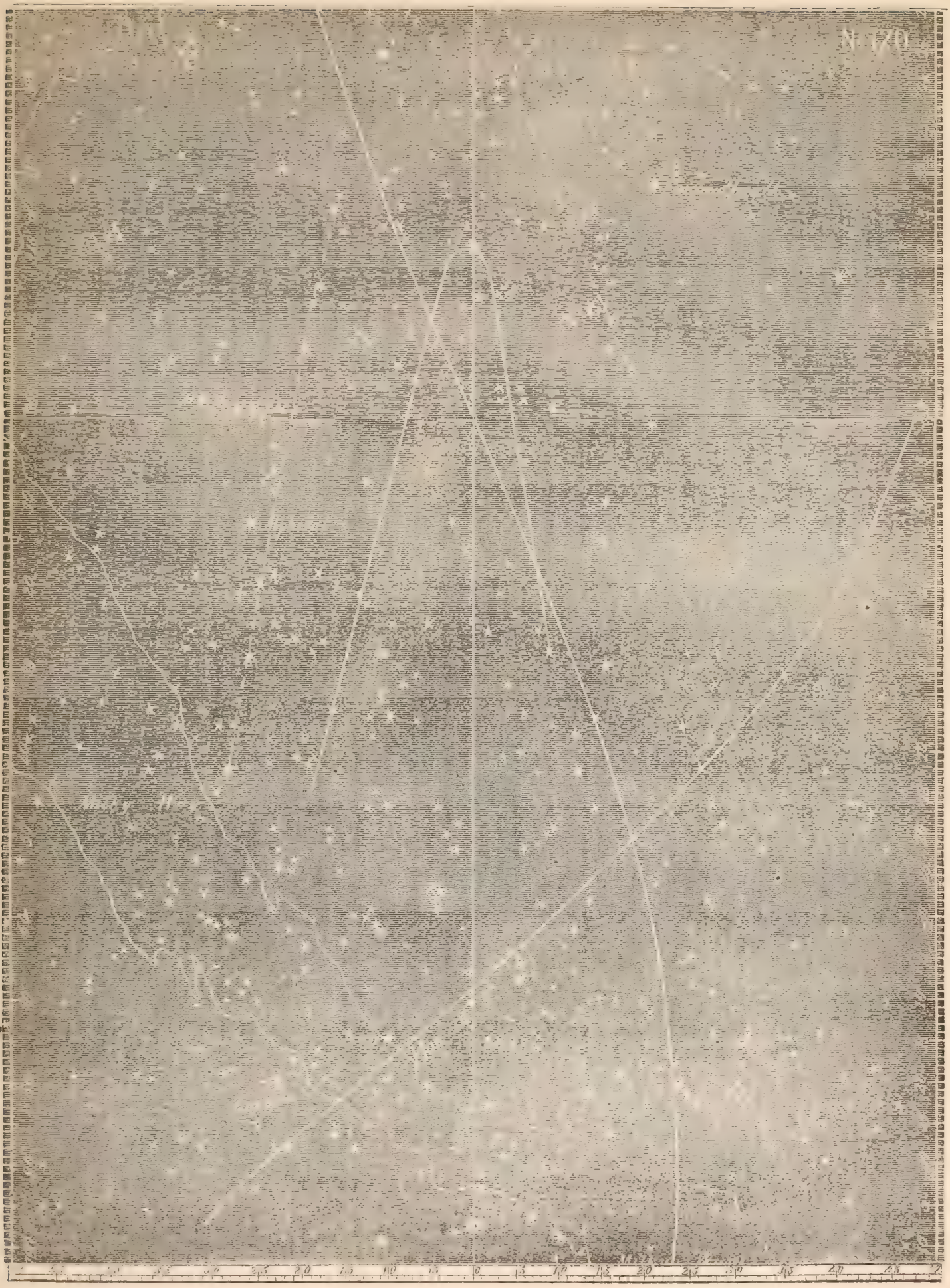

No 169

No. 170.

JUNE 29th, 1854: Morning.

Lat. at 3*h*., 30° 26′ N.: Lon. 136° 52′ E.
Sun rose 5*h*. 4*m*.
Stronger and Diffuse Light at 3 o'clock.

Clouds last evening. The moon, or clouds, in the morning, ever since my last morning date (8th instant). This morning, at 2^h 30^m, the Zodiacal Light was quite distinct; but, before I could note boundaries, the sky was all clouded over. Waited until it might clear; and at 3^h was able to have a good observation; the sky clear and pretty bright. The boundaries of the Stronger Light were not very well defined, as it ran gradually into the Diffuse Light, which is now brighter than it recently was; but I think those given may be depended on. The upper limits of the Diffuse Light could not be got, on account of the brilliancy of Jupiter, now in that region; but they may be inferred from the other portions.


N 170
Algenib
Markab

No. 171.

JUNE 29, 1854: EVENING.

Lat. at 10*h*., 28° 33′ N.: Lon. 136° 21′ E.
Sun set 6*h*. 57*m*.
Stronger and Diffuse Light at 10 o'clock.

Last evening, cloudy. Moon did not set this evening till about 9^h 52^m; then I got an observation (10 o'clock) as in the chart. The sky was perfectly clear and brilliant down to the horizon. The Zodiacal Light was dim at this hour, but quite distinct. The Stronger Light had well defined boundaries below *a a*; above that, it dimmed off, till at last it was difficult to ascertain its limits. In the morning observation, had been a new feature, namely: a departure of the lower line of the Stronger Light from parallelism to the ecliptic; and this evening I gave more particular attention to what I had suspected several evenings past, namely: a tipping up of the apex of this Light, so as to bring it to the right of the ecliptic line. I have put in the chart what seemed to be the termination; but the light there is so faint at 10^h, that I cannot speak positively. I give it as, after long and careful and repeated trials, it appeared to me to be.

At 10^h 20^m the Light was still distinct, as high as 29 Virginis, but dim; its boundaries the same as at 10 o'clock.

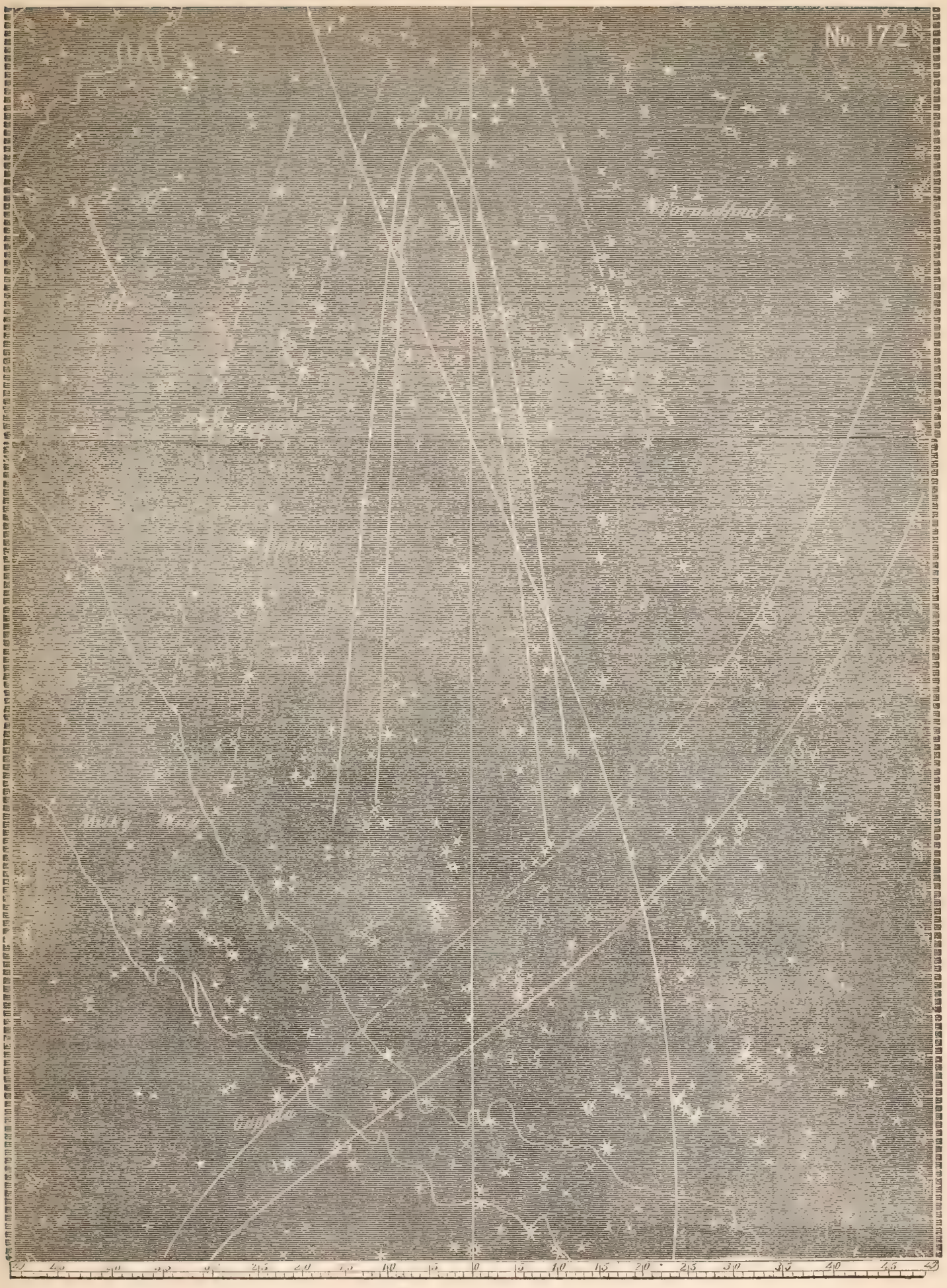
№ 171

No. 172.

JUNE 30th, 1854. Morning.

Lat. at 3*h*., 28° 22′ N.: Lon. 136° 15′ E.
Sun rose 5*h*. 10*m*.
Stronger and Diffuse Light at 2*h*. 30*m*. and 3*h*. 20*m*.

The sky this morning quite brilliant, and excellent for observations. At $2^h\ 30^m$ the Zodiacal Light very distinct; but the upper end is dimmed off to such a degree, that it is difficult to get boundaries there. I scarcely knew, this morning, whether to put down boundaries to the Diffuse Light or not, they were so indistinct and uncertain; but I have done the best I could. The difficulty was still further increased by the brilliancy of Jupiter. As dawn approached, say at $3^h\ 25^m$, the lower end of the Stronger Light grew very bright, but still kept strictly within the boundaries given. This lasted till about $3^h\ 40^m$, when the light spread, and dawn had come.


No. 172

No. 173.

JULY 1st, 1854: MORNING.

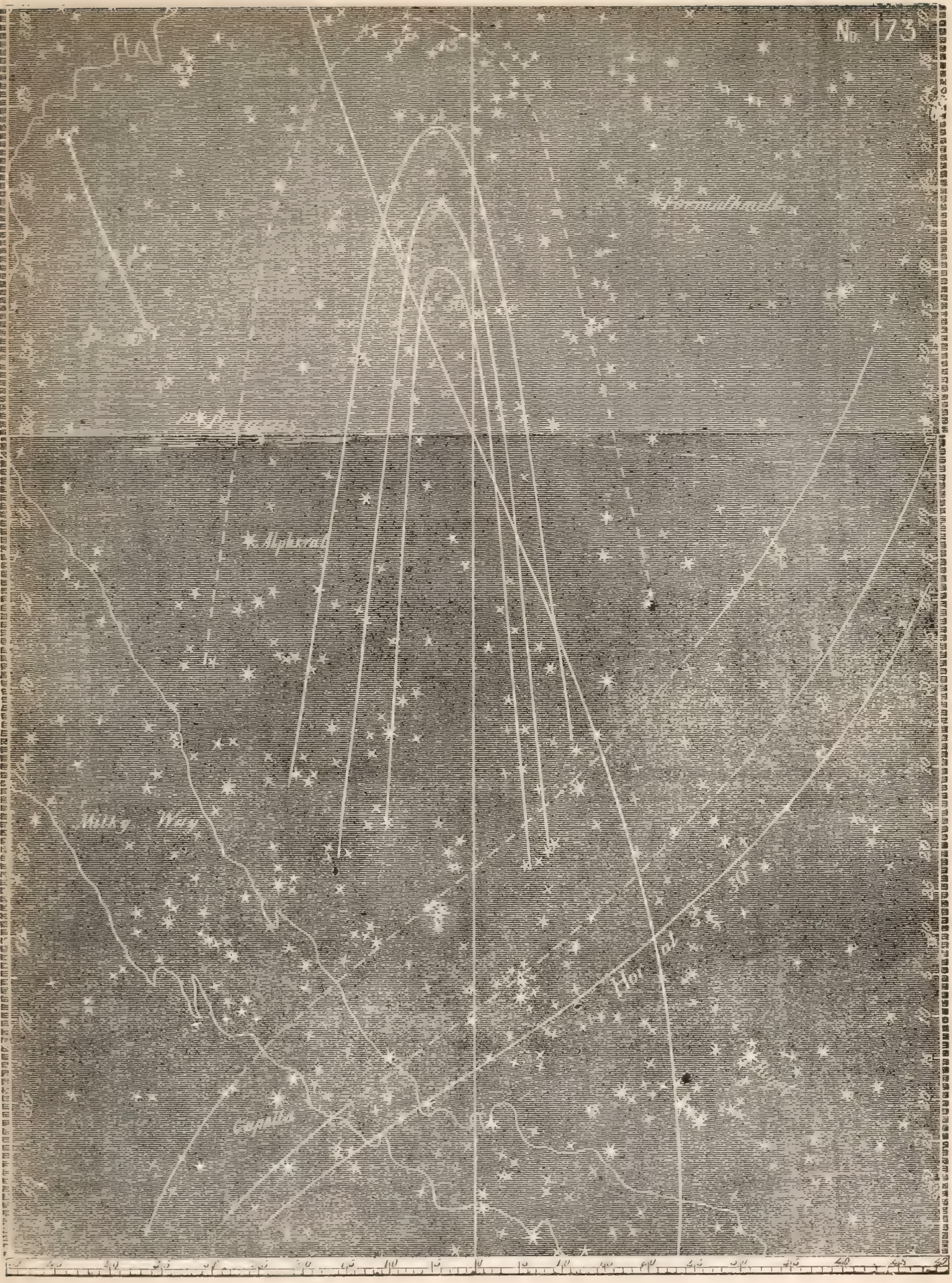
Lat. at 3*h*., 27° 35′ N.: Lon. 136° 8′ E.

Sun rose 5*h*. 12*m*.

Stronger Light { 2*h*. 0*m*. / 3 0 / 3 30 } Diffuse 2*h*. 45*m*.

Sun's Lon. 99° 15′.

Rose at 2^h, and found the Zodiacal Light quite distinct; the sky brilliant, but the view interrupted by flying clouds towards the horizon; in the intervals between these, I was able, however, to get reliable boundaries. The Diffuse Light, however, was so dim, that I could not get boundaries till $2^h\ 45^m$; and even then, and afterwards, this Light faded away so imperceptibly at its edges, that I had some doubts about trying to define it at all. The lower end of the Stronger Light is always much brighter than the upper: it dims as it ascends; and, at last, it is hard to say where its apex is; but the lines got below, which are fully reliable, help, by their convergency, to guide us along the less striking part above. Dawn about $3^h\ 40^m$.

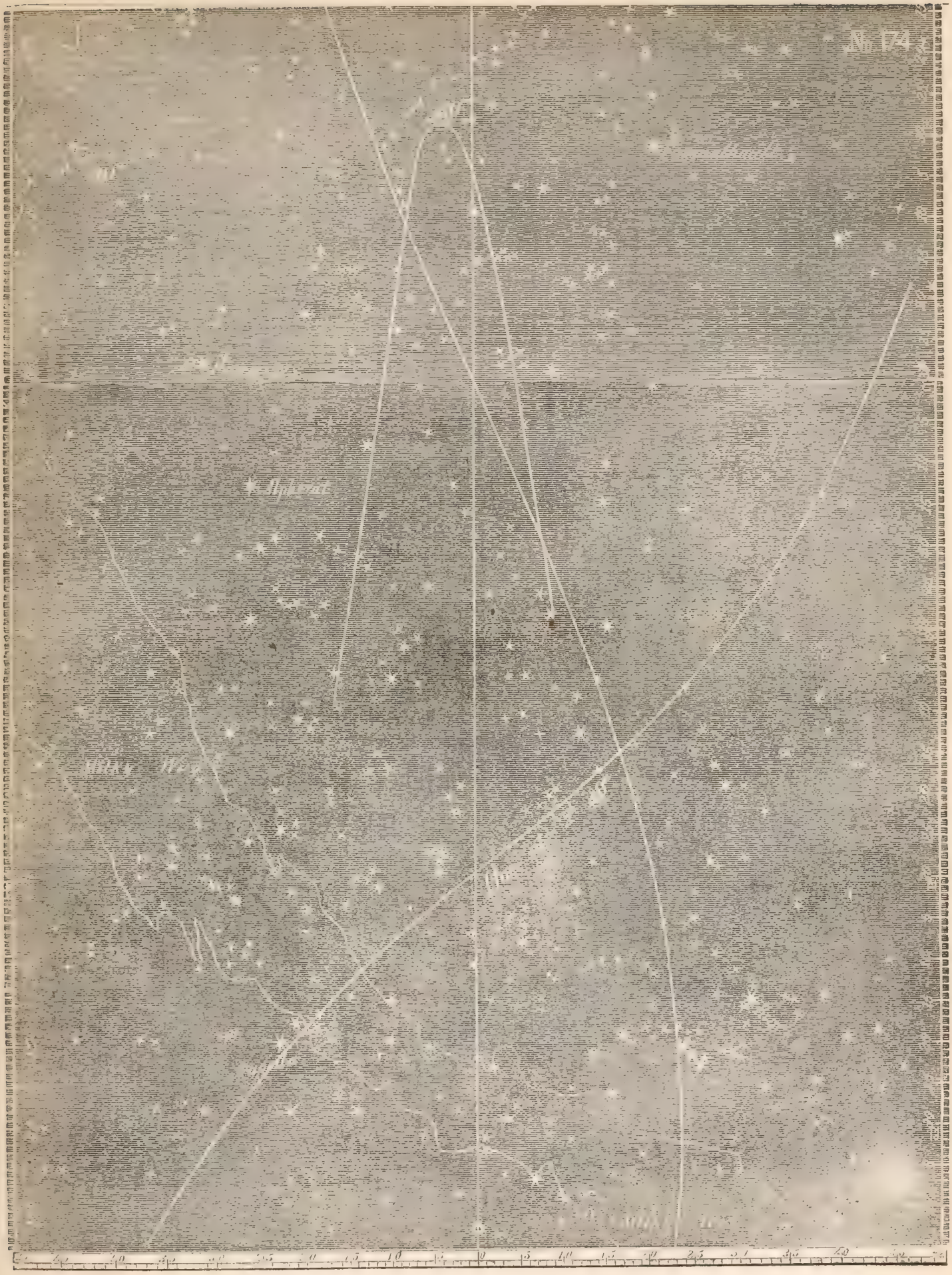

No. 173
Milky Way

No. 174.

JULY 4th, 1854: Morning.

Lat. at 2*h*. 30*m*., 28° 51′ N.: Lon. 132° E.
Sun rose 5*h*. 10*m*.
Stronger Light at 2*h*. 30*m*.

Clouds since last date. Rose at 2^{h}, but found the sky covered with flitting clouds. By watching, and catching outlines in the intervals between the clouds, I was able, by 2^{h} 20^{m}, to get the boundaries as in the chart. I think they are reliable; but the whole was so unsatisfactory that I made no further attempts. The Diffuse Light could not be defined at all. The clouds, however, had one advantage, inasmuch as they, by contrast where the Zodiacal Light could be seen, made it more striking, as they always do in such cases.

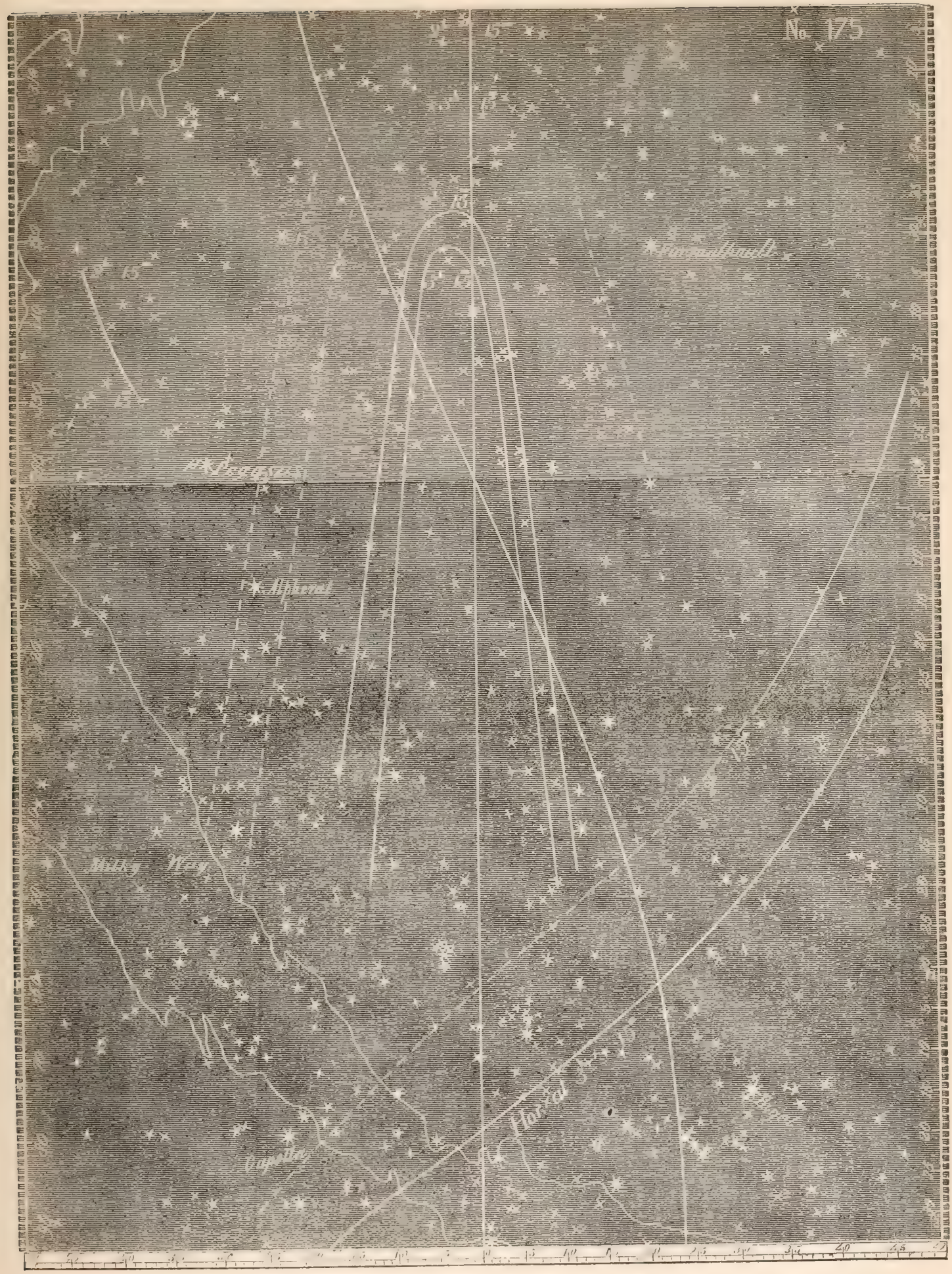


No. 175.

JULY 5th, 1854: MORNING.

Lat. at 3*h*., 29° 50′ N.: Lon. 130° 49′ E.
Sun rose 5*h*. 7*m*.
Stronger and Diffuse Light at 2*h*. 15*m*., and 3*h*. 15*m*.
Sun's Lon. 103° 41′.

At 2 a. m. found the sky rather dull, but was able to get a reliable observation, except at the lower side of the Diffuse Light, which was hidden by a thick haze lying at that part of the horizon. At $3^h\ 15^m$, the sky was brighter, and I got more satisfactory results. I have put the upper end of the Diffuse Light in dots, as that portion was made doubtful, both by the dimness of the Light and by the brightness of Jupiter.


No. 175
Aquarius
Milky Way
Capella

No. 176.

JULY 6th, 1854: Morning.

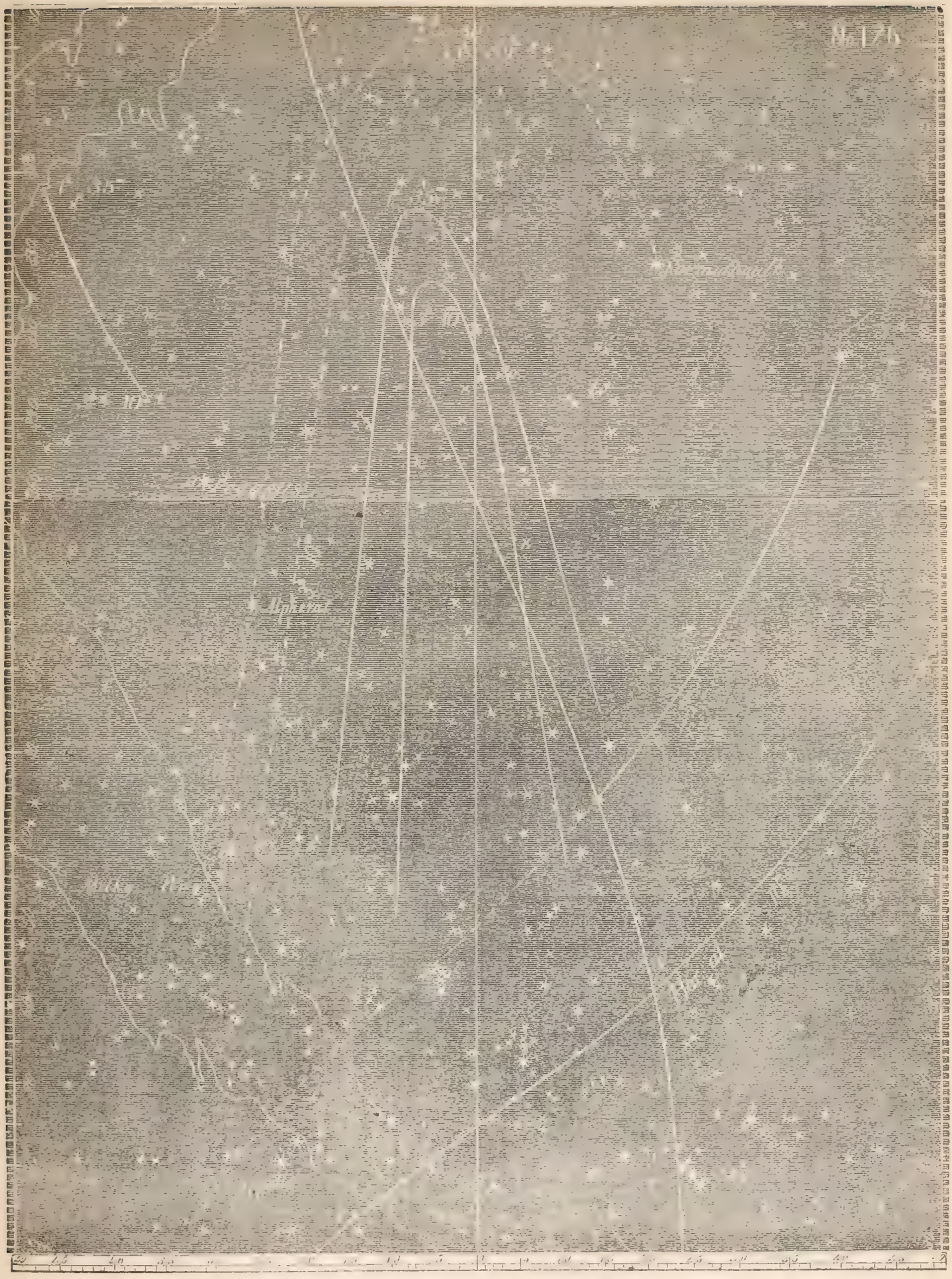
Lat. at 3*h*., 29° 18′ N.: Lon. 129° 37′ E.

Sun rose 5*h*. 10*m*.

Stronger Light { 1*h*. 35*m*. / 3 10 } Diffuse Light 1*h*. 52*m*. and 3*h*. 10*m*.

Sun's Longitude 104° 1′.

Was on deck at half-past 1, and was surprised to find the Zodiacal Light so distinctly marked and so well defined. Got reliable boundaries at 1ʰ 35ᵐ for the Stronger Light, but, on account of some flitting clouds, could not bound the Diffuse till somewhat later. Again on deck at 3 o'clock, but found the sky now rather dull, and was not able to get the lower boundary of the Diffuse Light reliably. At both observations, the upper extremity of the Stronger Light was badly marked, but I believe the boundaries given may be relied on.


N. 174

No. 177.

JULY 7th, 1854: MORNING.

Lat. at 3*h*., 28° 56′ N.: Lon. 127° 52′ E.

Sun rose at 5*h*. 11½*m*.

Stronger Light at { 2*h*. 50*m*. / 3 15 } Diffuse 3*h*.

Sun's Lon. 104° 58′.

Was not waked till 2ʰ 30ᵐ: found the sky very brilliant, but broken by flying clouds. Between these, however, I was able, finally, to get complete boundaries both of the Stronger and Diffuse Light. At 3ʰ, was driven below by a rain squall. This passed, and then had a good observation at 3ʰ 15ᵐ. I am particularly careful now about the boundaries, on account of the unusual course of the Zodiacal Light—for which see the chart. The observation at 3ʰ 15ᵐ, and also the boundaries of the Diffuse Light, I think may be considered fully reliable. Was somewhat puzzled, this morning, by what seemed to be rapid changes in the width of the Stronger Light at its lower and more decidedly marked end, and suspect that they were pulsations; but though the sky was very brilliant, I had no opportunity to decide on this matter. At 3ʰ 25ᵐ a heavy rain squall came up, and the sky was immediately all covered over with clouds.

No. 178.

JULY 8th, 1854: MORNING.

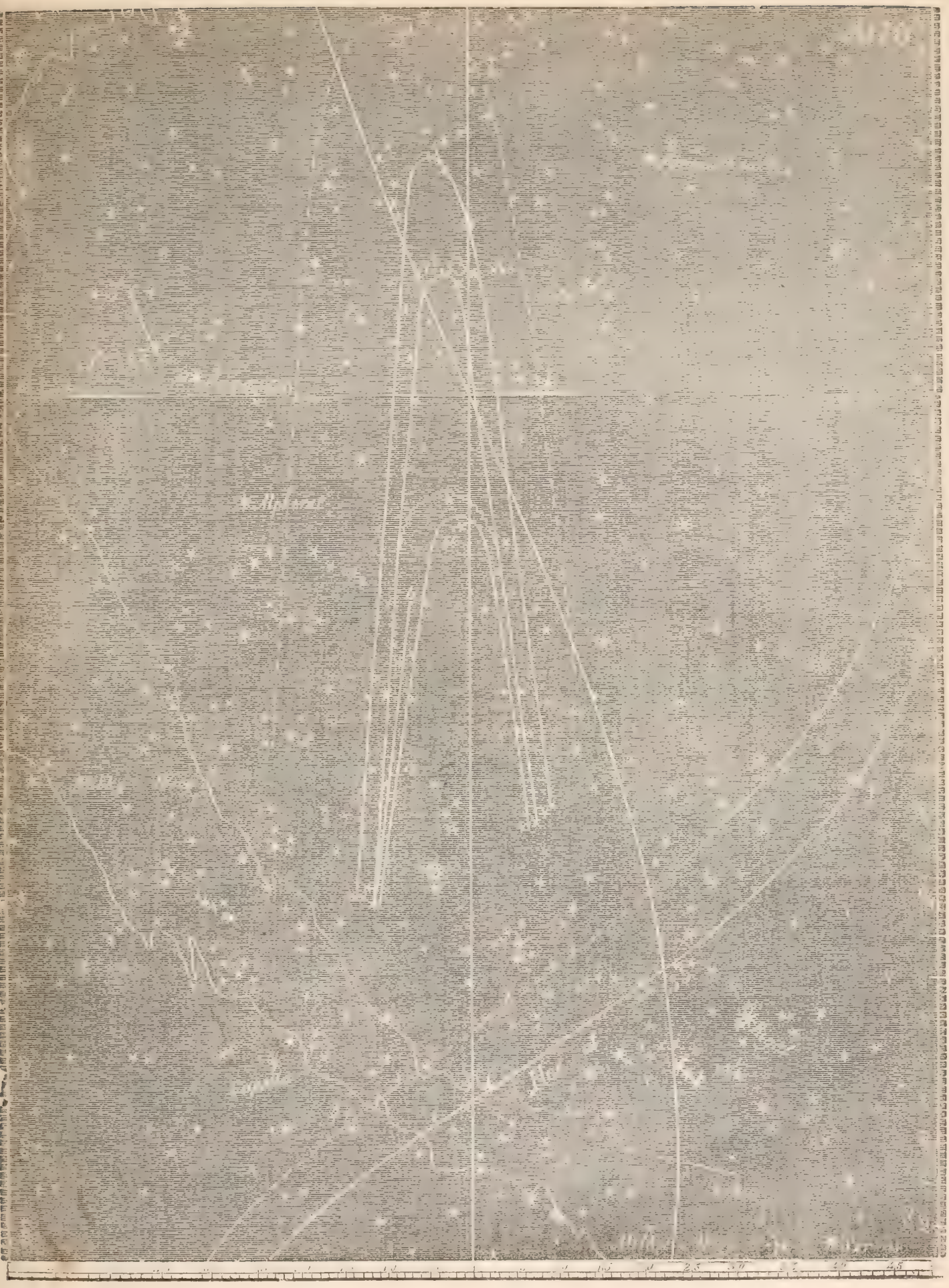
Lat. at 3*h*, 29° 14′ N: Lon. 126° 26′ E.

Sun rose at 5*h*. 11⅔*m*.

Stronger Light at { 3*h*. 0*m*. / 3 35 &c. } Diffuse 3*h*.

Sun's Lon. 105° 55′.

The moon interfered, this morning, till 3 o'clock, when I was able to get an observation; the sky, though not brilliant, still very favorable. I have marked by the zigzag line the height to which the strongest part of the Stronger Light appears to ascend, though it tapers off so gradually that it is difficult to draw a distinctive mark, while it is evident that the Light below is much brighter than higher up. I thought several times that there were pulsations, and on one occasion took notes thus: 3^h 26^m, the brightest part dim and at *a*; 3^h 28^m, do.; 3^h 29^m, brightening: 3^h 32^m, at *b*, and brighter; 3 36^m, do. do. But I cannot present these annotations as reliable; the changes, if there were any, being so uncertain, although I watched with the greatest care. Soon after 3^h 36^m commenced a permanent gradual brightening; and at 3^h 43^m dawn had come.

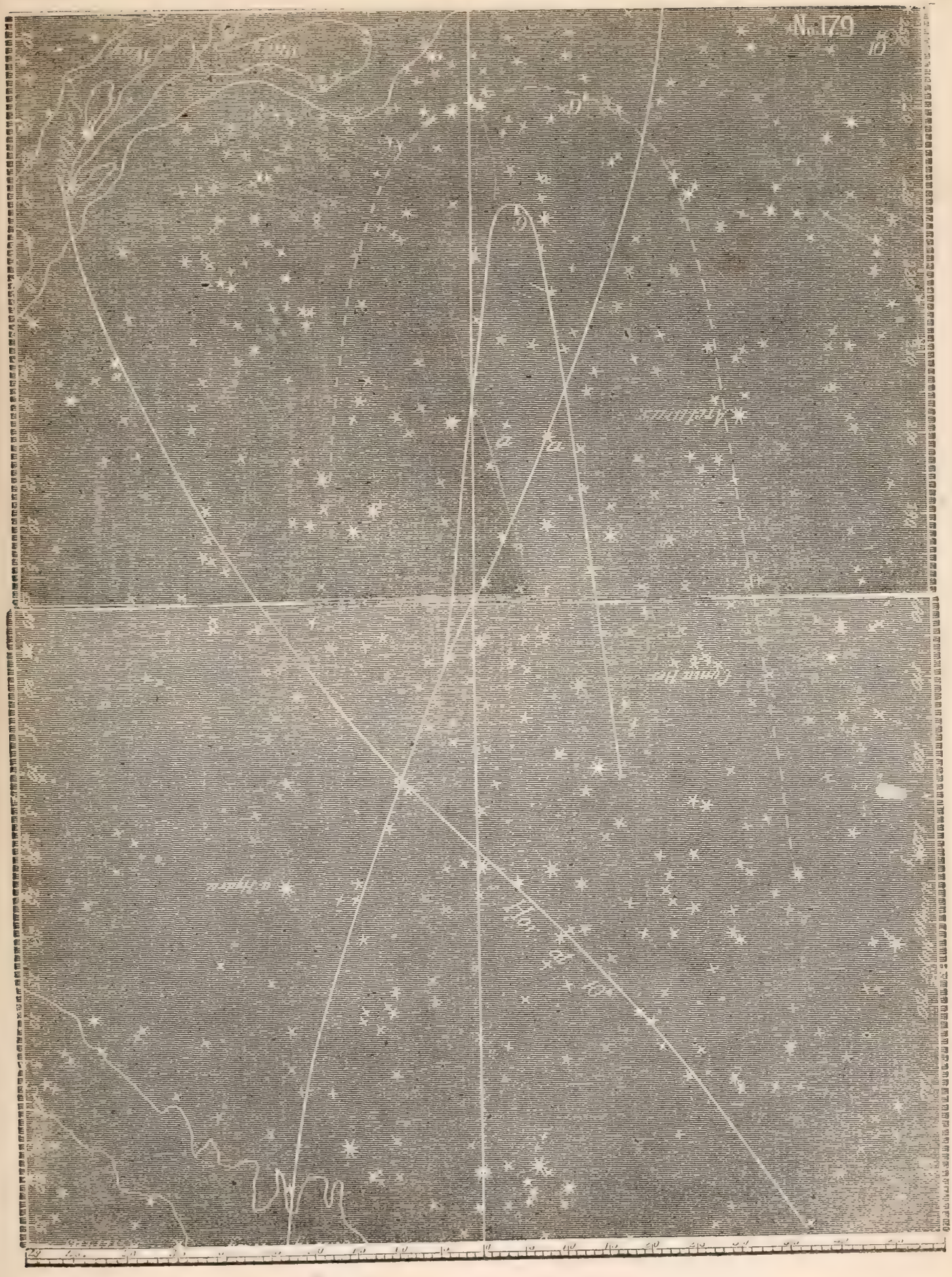


No. 179.

JULY 13th, 1854: Evening.

Lat 25° 9′ N: Lon. 121° 46′ E.
Sun set 6*h*. 48*m*.
Stronger and Diffuse Light at 9*h*.

Moon and thin clouds since my last, both morning and evening. The early part of this evening cloudy; but at 9^h I was surprised to find the sky clear and remarkably brilliant—very good for observations. Had a careful one at 9^h, particularly so as respects the angle which the Zodiacal Light seems now to make with the ecliptic. For result, see the chart. The lower end of the Stronger Light, as high as about α α, is bright; above this, it goes tapering off, so as at last to be very dim. Still, as I made repeated trials of observation, and always with the same result, I think the outlines given may be relied on. Soon after 9^h, clouds arose and prevented further observations.


N. 179

No. 180.

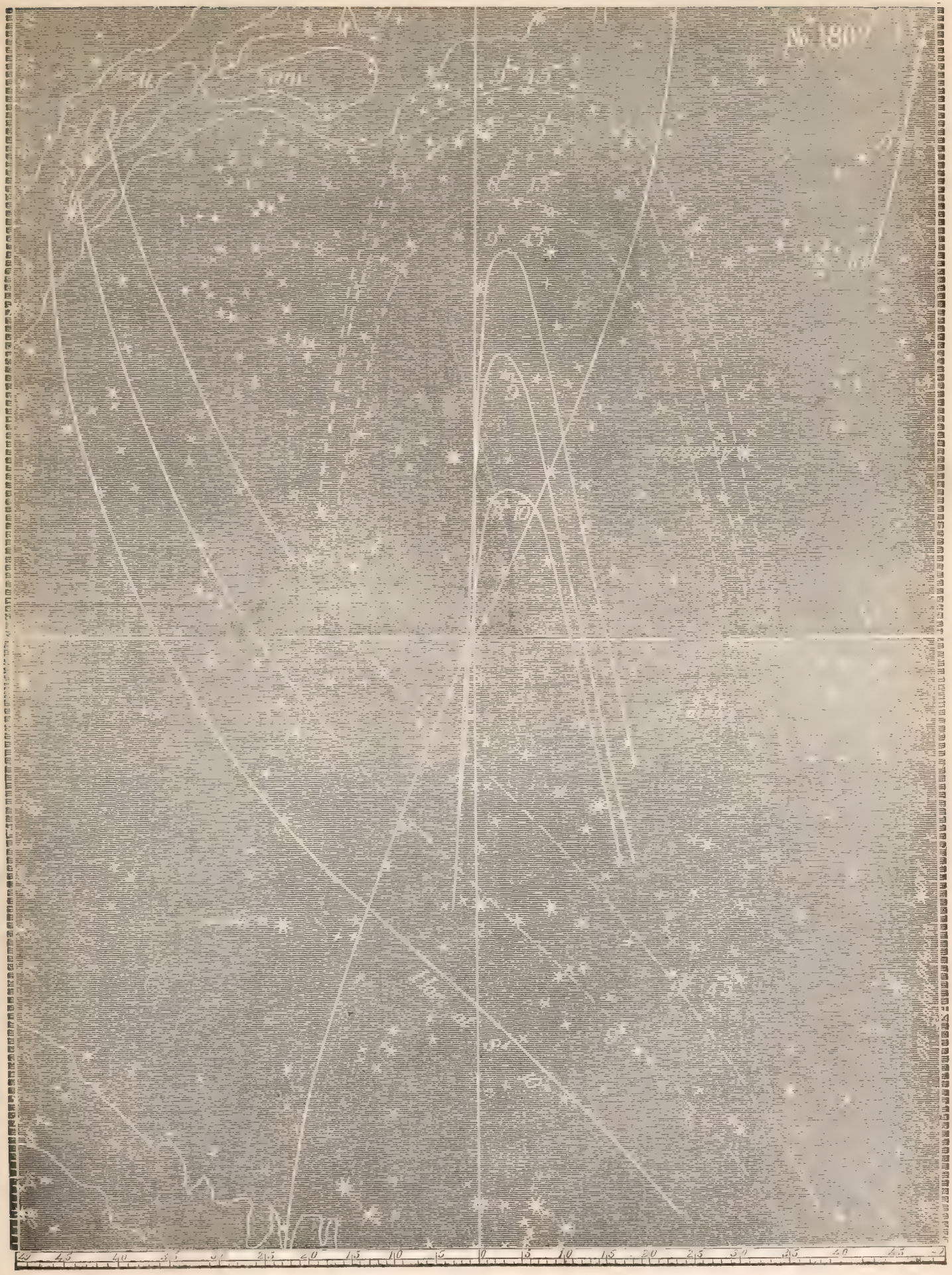
JULY 14th, 1851: EVENING.

Lat. 25° 9′ N.: Lon. 121° 46′ E.

Sun set 6*h*. 47½*m*.

Stronger and Diffuse Light at	*h*.	*m*.
	8	15
	9	0
	9	45

A clear and brilliant evening. Got observations at $8^h\ 15^m$, &c., as in the chart. At 9^h the Stronger Light was dim above 29 Virginis. At that time it possibly extended up to α Libræ, but I could not be certain about it. At $9^h\ 45^m$, both Diffuse and Stronger Light quite distinct, and at 10^h also; though the Stronger Light had then dimmed very much.

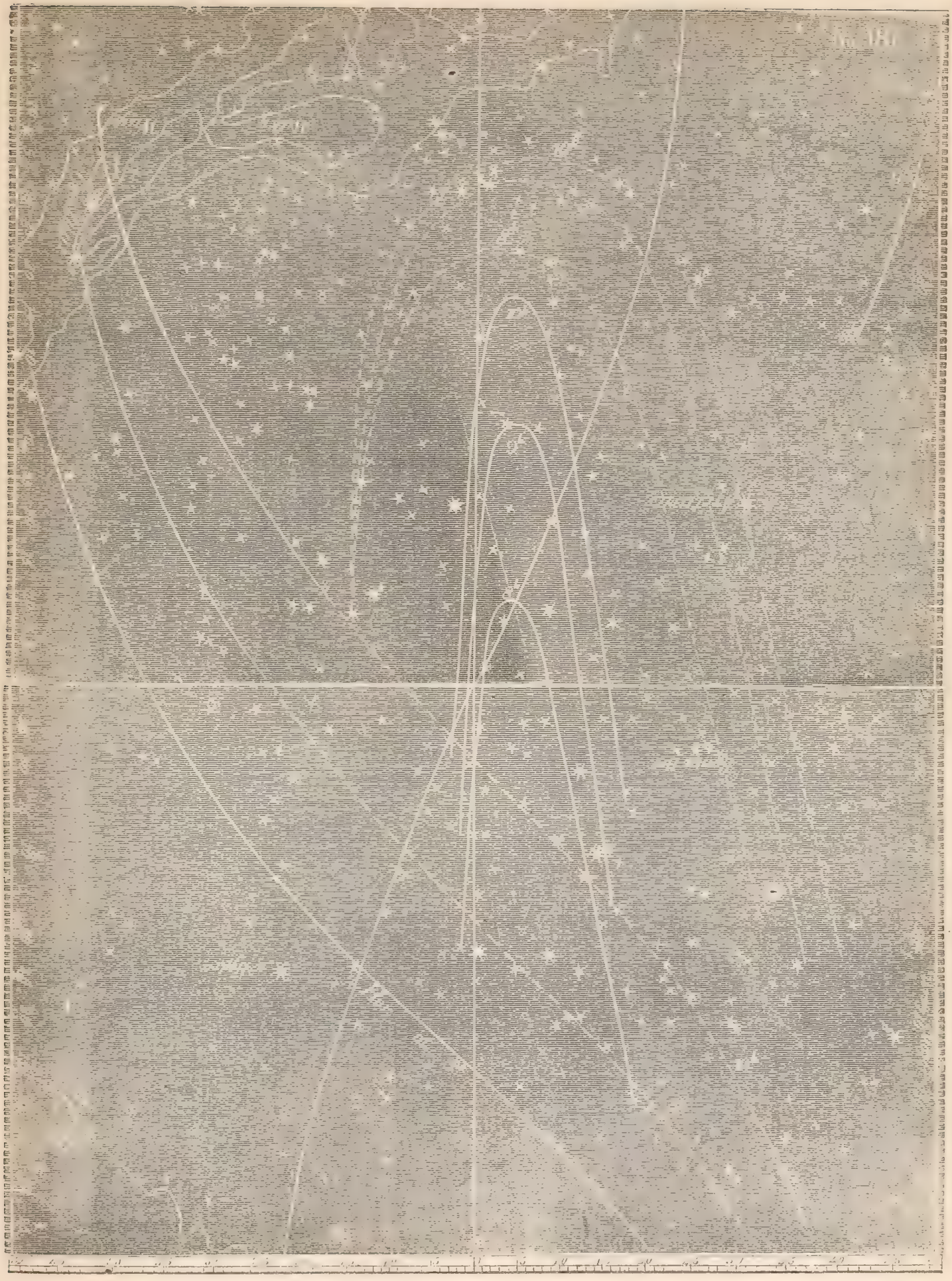

N. 180°

No. 181.

JULY 15th, 1854: Evening.

Lat. 25° 9′ N.: Lon. 121° 46′ E.
Sun set 6*h*. 48*m*.
Stronger and Diffuse Light at 8, 9, and 10 o'clock.

At 8 o'clock the Zodiacal Light was quite distinct; but the upper end of the Diffuse was not easily made out; at 9^h, the latter was better defined. The sky was remarkably brilliant. The upper end of the Stronger Light was comparatively dim. I have given its boundaries, after very careful study. About 8^h 30^m, this Stronger Light seemed to have a rapid ascent, and brightening, from its former position at 8^h. At 10^h the Stronger Light had dimmed very greatly, and its upper end was scarcely distinguishable from the Diffuse Light, which now was very decided and well defined. At 10^h 30^m the Stronger Light could not be defined at all, and the Diffuse could scarcely be made out.

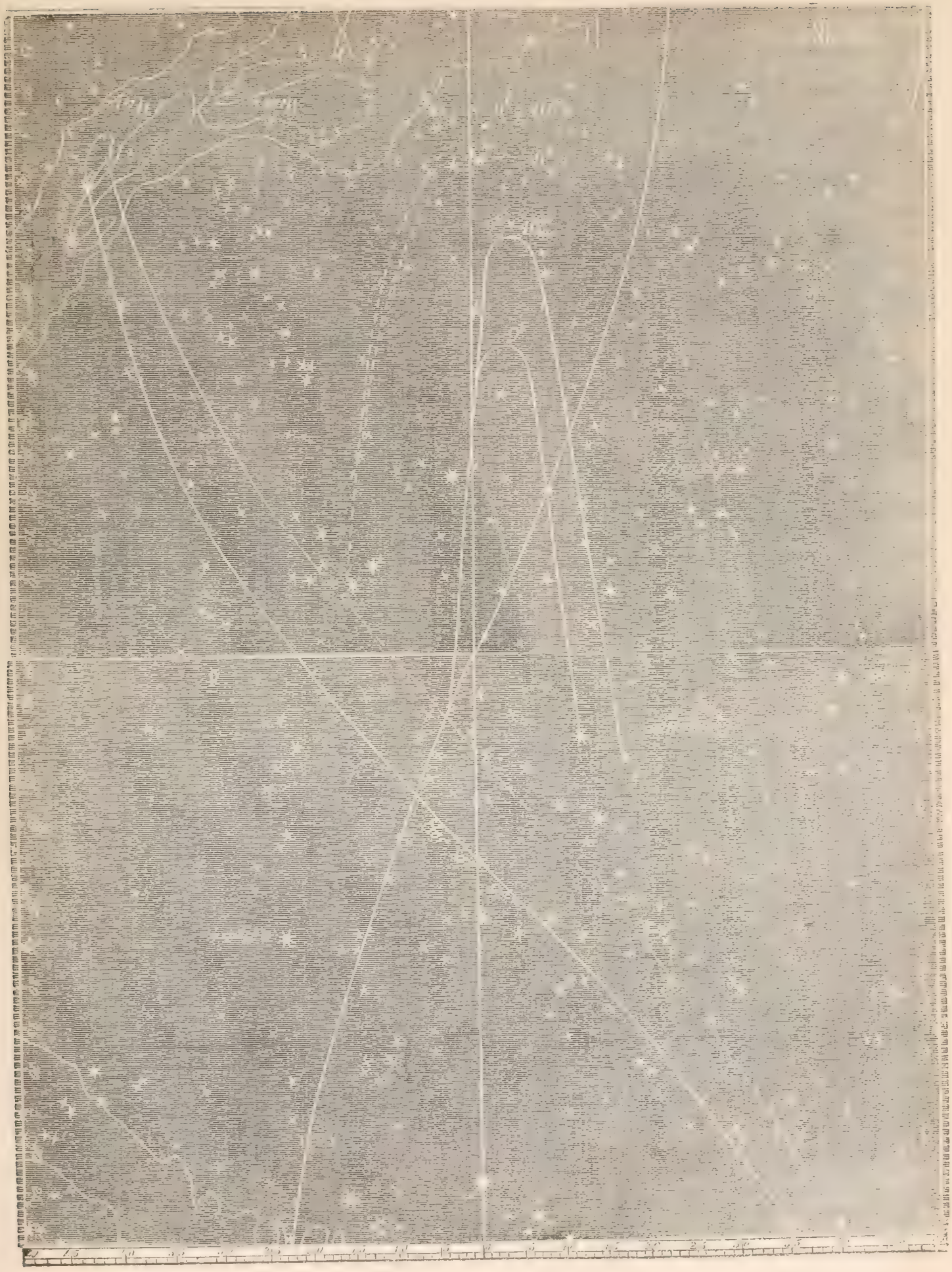


No. 182.

JULY 18th, 1854 (16th was Sunday): EVENING.

Lat. 25° 9′ N.: Lon. 121° 46′ E.
Sun set 6*h*. 47*m*.
Stronger and Diffuse Light at 9*h*. and 9*h*. 40*m*.

Last evening, clouds. Clouds this evening, also, till 9 o'clock, when I was able to have a good observation, the sky being very bright. At 9ʰ 40ᵐ the Light was very well defined, except the upper end of the Stronger Light, where, however, my outlines, I think, may be fully relied on. The Diffuse Light was very well defined and very distinct.



No. 183.

JULY 19th, 1854: EVENING.

Lat. 25° 9′ N.: Lon. 121° 46′ E.
Sun set 6*h* 47*m*.
Stronger and Diffuse Light at 8*h*. 3 *m*. and 9*h* 30*m*.

I was absent in a boat, and did not get back to the ship till 8^{h} 30^{m}, when I had a very good observation; the sky clear and very bright—so also at 9^{h} 30^{m}; but at this latter hour, the Stronger Light had dimmed considerably.

No. 184.

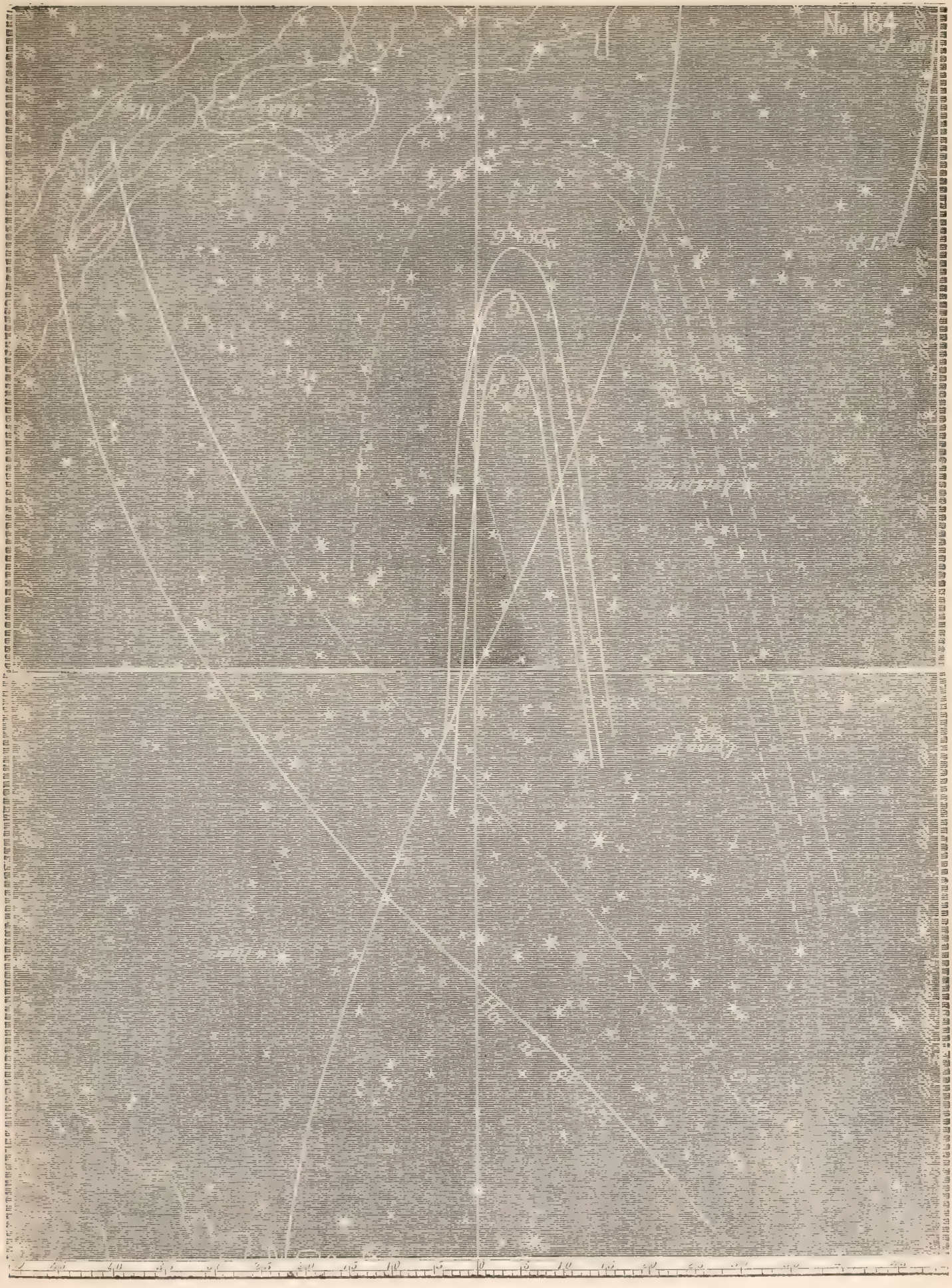
JULY 20th, 1854: Evening.

Lat. 25° 9 N.: Lon. 121° 46′ E.

Sun set 6*h*. 47*m*.

Stronger and Diffuse Light at { 8*h*. 15*m*. / 9 0 / 9 30

The Zodiacal Light was quite distinct at 8ʰ 15ᵐ. It seemed to be brightest of all at 9ʰ. The sky was very clear and bright. At 9ʰ 30ᵐ, took boundaries; but the Light was then so dim that it was difficult to get them so as to be fully reliable.


No 184

No. 185.

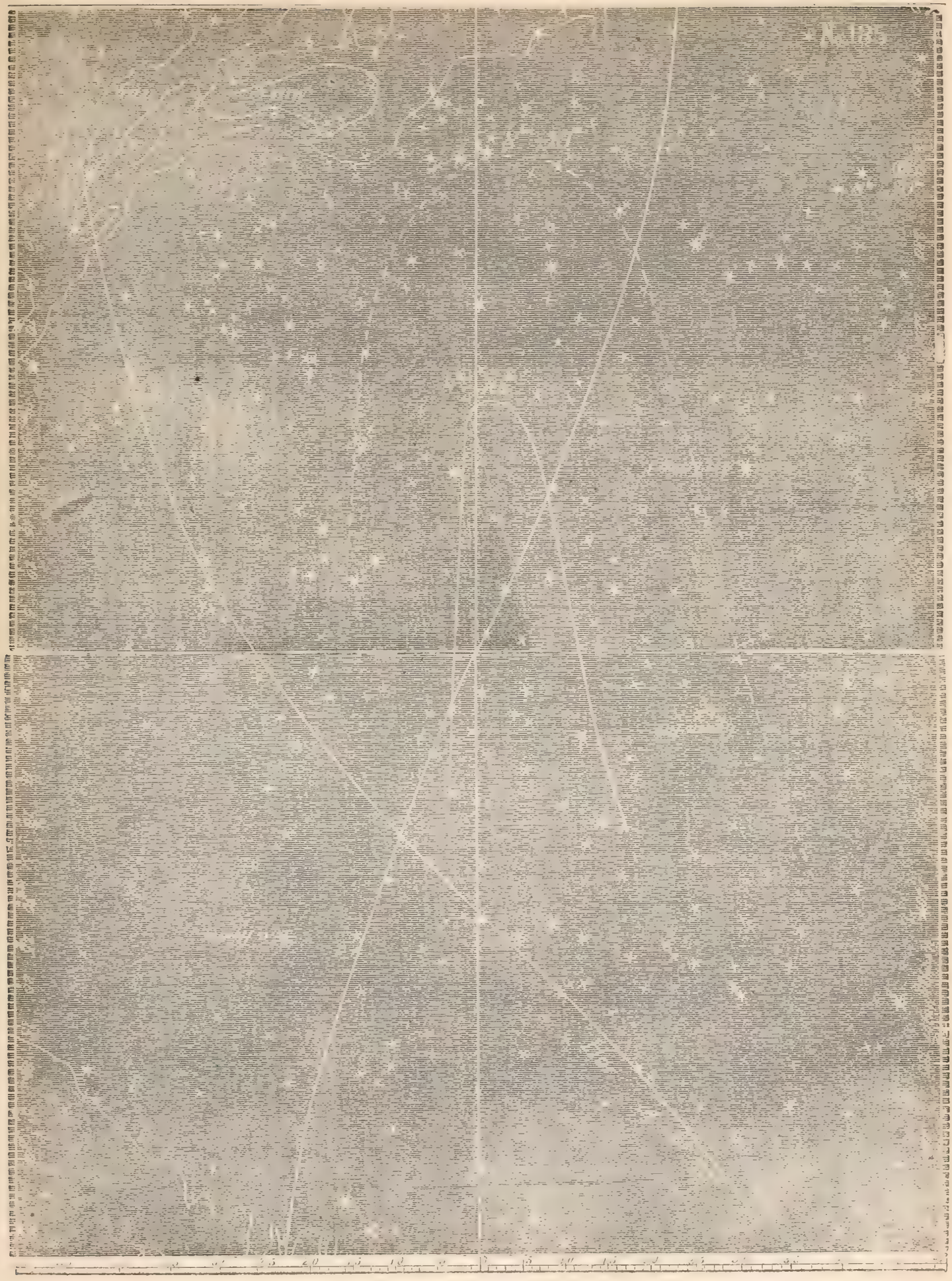
JULY 21st, 1851: Evening.

Lat. 25° 9′ N.: Lon. 121° 15′ E.

Sun set 6*h*. 4 *m*.

Stronger and Diffuse Light at 8*h* 30*m*.

Was absent in a boat till 8ʰ 30ᵐ; then I had a very good observation. Sky very bright; clouds arose soon after this, and I got no further observations.



No. 186.

JULY 22d, 1854: EVENING.

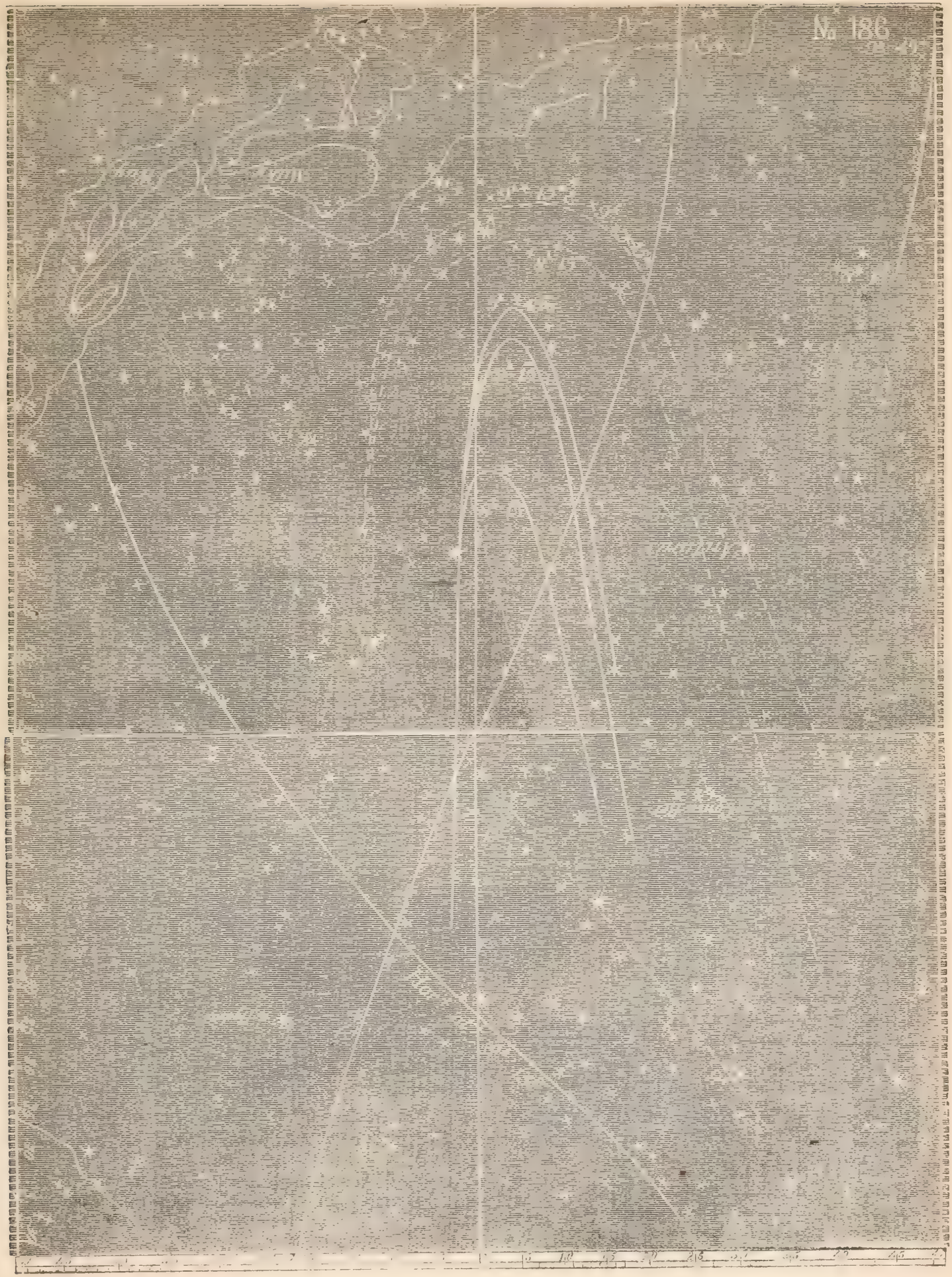
Lat. 25° 9′ N.: Lon. 121° 46′ E.

Sun set 6*h*. 46*m*.

Stronger and Diffuse Light at { 8*h*. 15*m*. / 9 15 / 9 45

Sun's Lon. 119° 17′.

Sky very bright and clear. At 8^h 15^m, the Zodiacal Light quite distinct. At 9^h 15^m, the Stronger Light was dim, for that early hour; but I was able still, at 9^h 45^m, to get boundaries, though the Light, both Stronger and Diffuse, had very much faded.

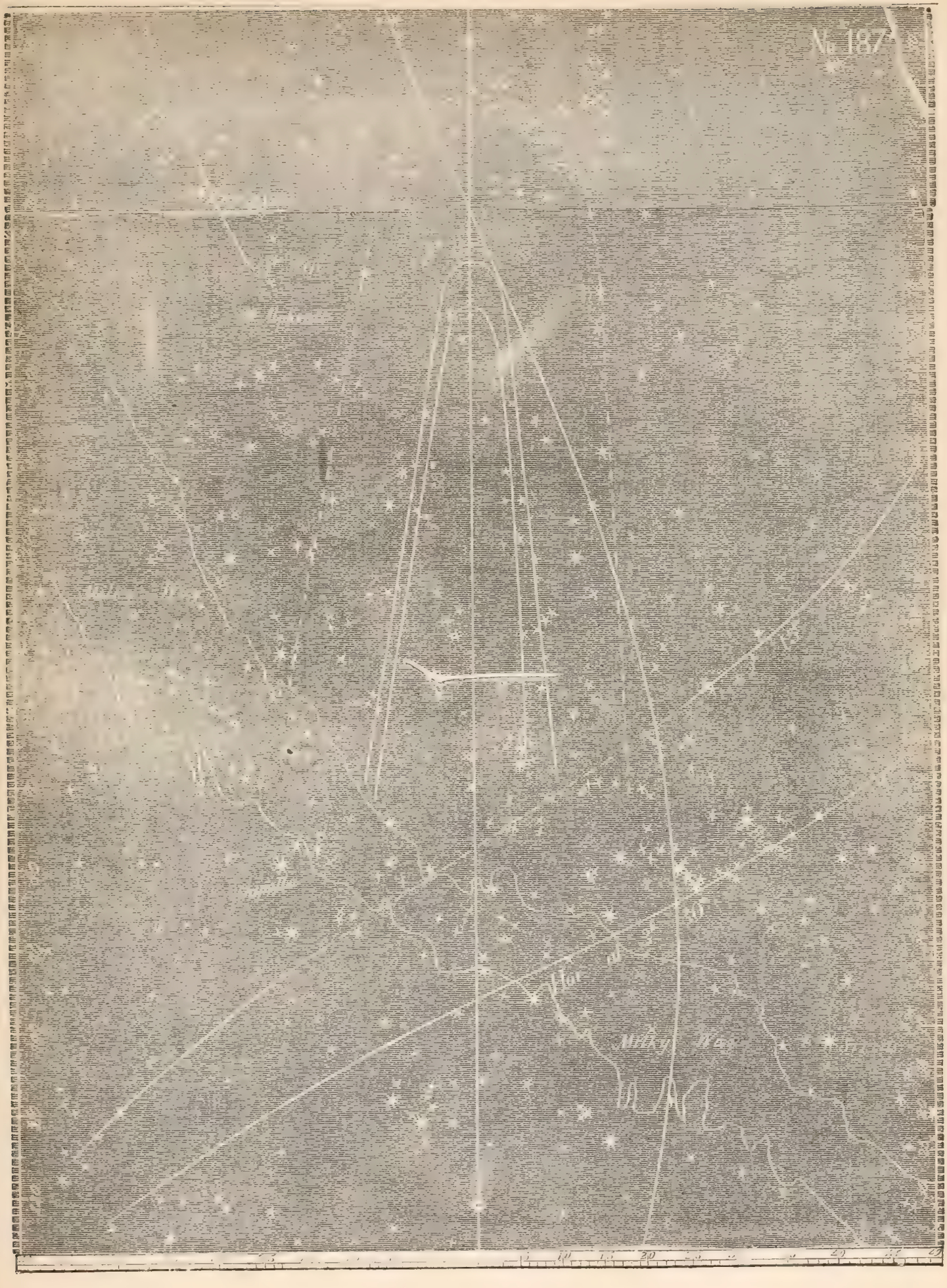

No 136

No. 187.

JULY 24th, 1854 (23d was Sunday): MORNING.

Lat. at 3*h*., 25° 39′ N.: Lon. 121° 37′ E.
Sun rose 5*h*. 26*m*.
Stronger and Diffuse Light at 2*h*. 30*m*. and 3*h*. 15*m*.

Moon in the morning since the 8th. Was on deck at 2^h, and found the Zodiacal Light quite distinct; but on account of flitting clouds, could not get boundaries till 2^h 15^m. Sky all clouded over at 3^h, but clear again at 3^h 30^m, when I had a very good observation. The Stronger Light now, in the morning, is very bright; but the Diffuse is dim—just the reverse of what we have in the evening. Once or twice I thought that there were pulsations in the intensity of the Stronger Light; but Venus is now so bright at the lower end of the Light, that it is difficult to tell. Dawn about 4 o'clock.


No. 187

No. 188.

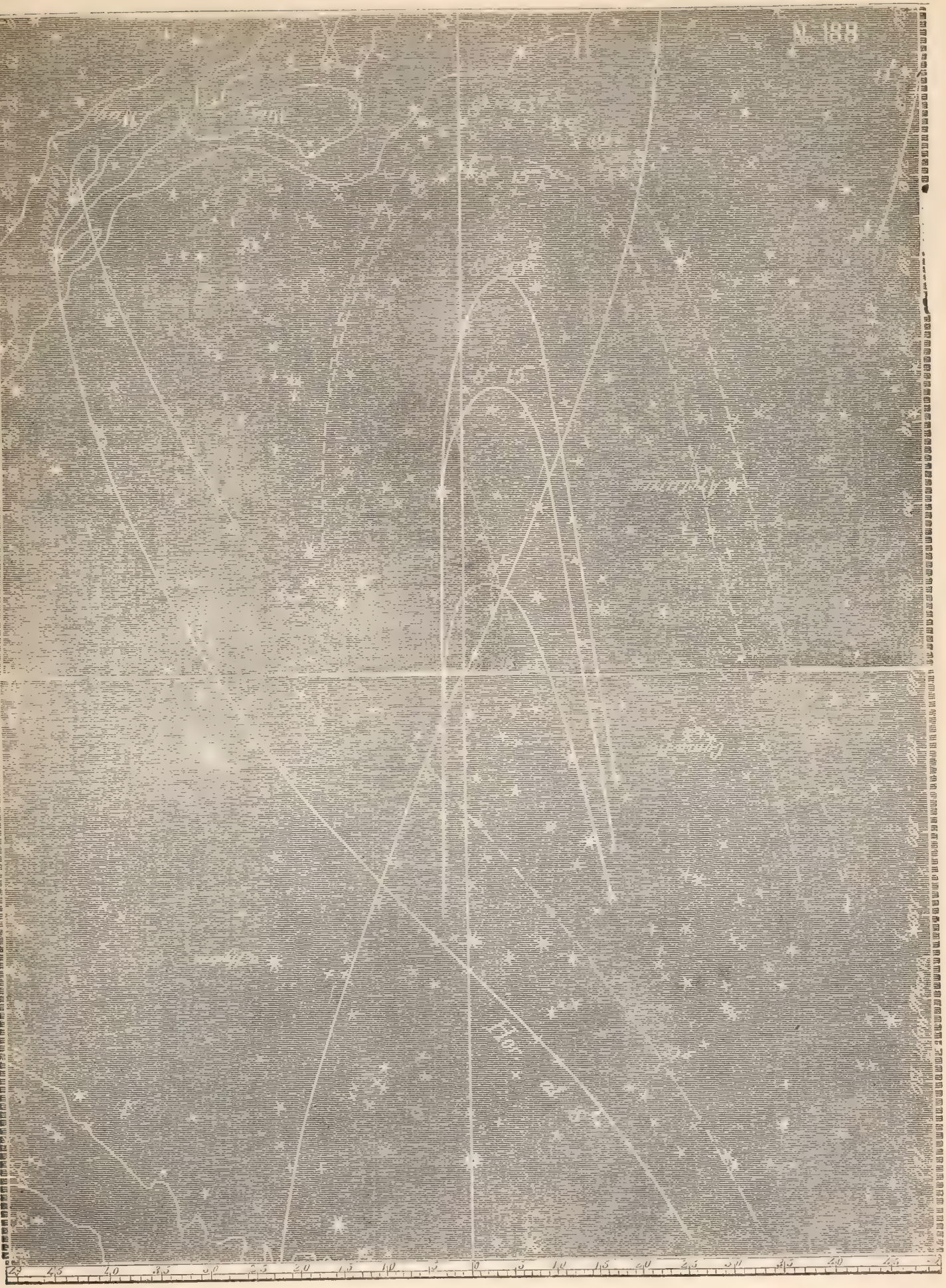
JULY 24th, 1854: Evening.

Lat. at 8*h*., 25° 38′ N : Lon. 120° 39′ E.

Sun set 6*h*. 46*m*.

Stronger Light at { 8*h*. 0*m*. / 8 15 / 8 45 } { 8*h*. 15*m*. / 8 45 / 9 45 } Diffuse.

Sky clear. At 8 o'clock the Zodiacal Light was quite distinct at its lower end, as in chart; but the night had not yet deepened sufficiently to show it further up. As the darkness increased, it ascended rapidly; and at $8^h\ 15^m$ the boundaries were as given for that hour in the chart. It seems to be brightest at about $8^h\ 45^m$. The Diffuse Light is strongly marked, and I noticed again the contrast in intensity between the present evening and morning Diffuse Light. At $9^h\ 45^m$ I could define this latter well, but could not get boundaries for the Stronger. The latter appeared to have melted gradually into the Diffuse.

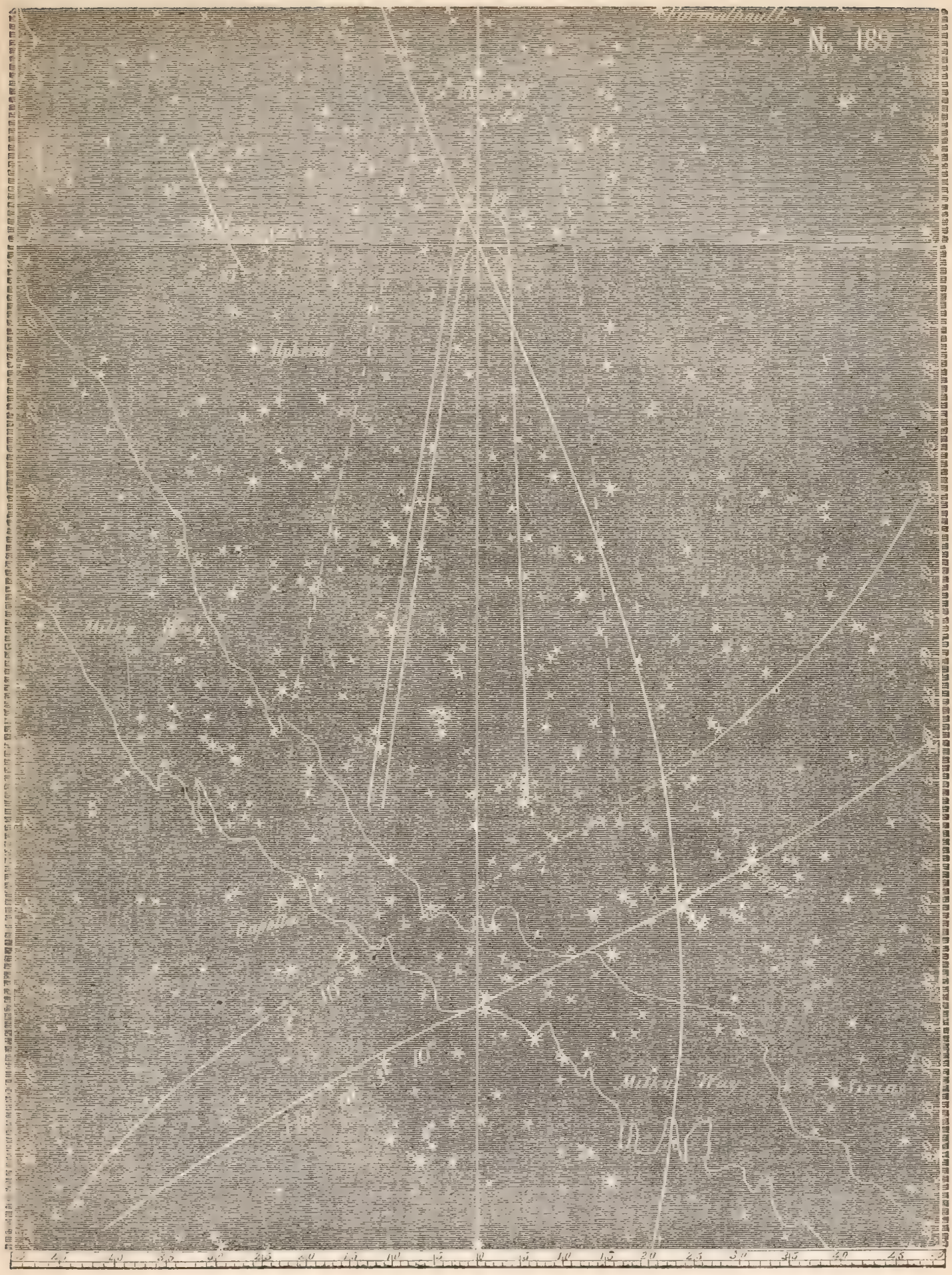

N. 188

No. 189.

JULY 25th, 1854: Morning.

Lat. at 3*h*., 25° 31′ N.: Lon. 120° 41′ E.
Sun rose at 5*h*. 27*m*.
Stronger and Diffuse Light at 2*h*. 10*m*. and 3*h*. 10*m*.

Was on deck at 2 o'clock, and found the Zodiacal Light very strong for that early hour. Sky bright and clear. Another observation at 3ʰ 10ᵐ; soon after which, a mist overspread the sky.

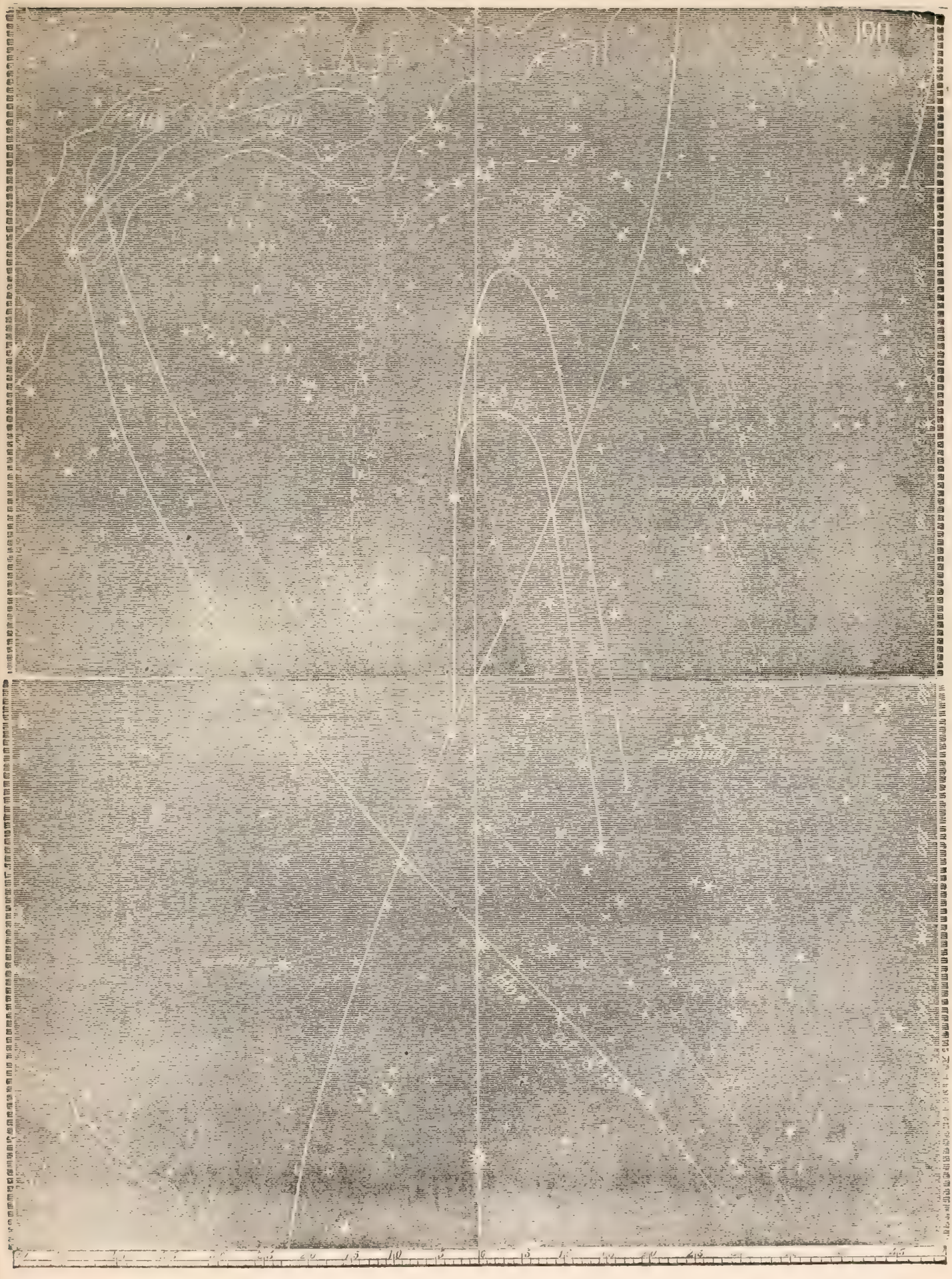

No 187
Milky Way
Milky Way
Milky Way

No. 190.

JULY 25th, 1854: EVENING.

Lat. at 8*h*., 25° N.: Lon. 120° 28′ E.
Sun set 6*h*. 44*m*.
Stronger and Diffuse Light at 8*h*. 15*m*. and 9*h*.

Watched to see the first appearance of the Zodiacal Light. In the portion of the sky immediately over the sun, now set, there lingered a reddish light till near 8 o'clock, when it faded rapidly away, and then a light, which had just before begun to turn upward towards the left, became soon developed as the Stronger Zodiacal Light. This, however, did not reach its full height till at $8^h\ 15^m$, when I took its boundaries. It now had a more gradual ascent, as the evening passed, till at 9^h, its boundaries were up to α and β Libræ. At 9^h the Stronger Light had dimmed considerably, and soon after it was scarcely, if at all, distinguishable from the Diffuse Light. At 10^h the latter was discernible, but I could not get reliable boundaries.



No. 191.

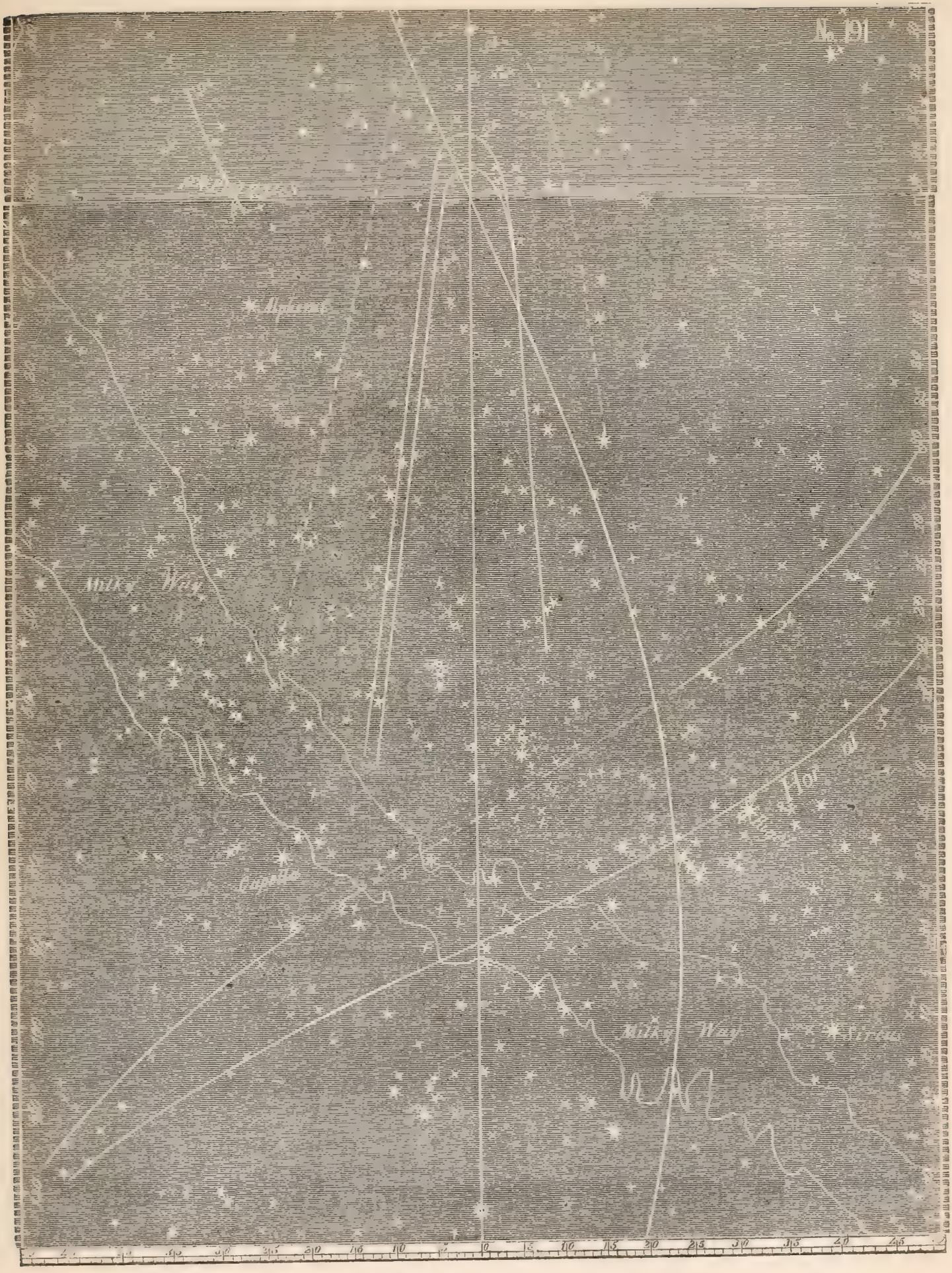
JULY 26th, 1854: Morning.

Lat. at 3*h*., 24° 24′ N.: Lon. 120° 4′ E.
Sun rose at 5*h*. 29*m*.
Stronger Light at 2 and 3 o'clock: Diffuse at 3 o'clock.

Was up at $1^h\ 30^m$, in order to see whether the Zodiacal Light was visible at that hour or not. The sky was unfavorable, not being bright, and there were clouds also at the eastward. I thought the Zodiacal Light was plainly distinguishable between the clouds; but I could not get boundaries before 2 o'clock; succeeded also at 3^h; but both at 2 and 3 o'clock, the Zodiacal Light had a very singular appearance, such as I had never noticed before. The Zodiacal Light is usually a clear transparent light, with a slightly yellowish tinge; and the stars, which are behind, are but slightly dimmed by it; but, on this occasion, it looked as if it had all been *muddied*. The stars back of it were much dimmed or quite obscured; while, on each side, though not shining with the brilliancy frequently seen (the sky a little hazy), they were as in other parts of the sky. I consequently got the outlines, particularly of the Stronger Light, with more ease than I commonly do.

(P. S. 26th July, 10^h a. m. Sky overcast and threatening since sunrise.)

(P. S. 29th July. This was followed by a gale.)

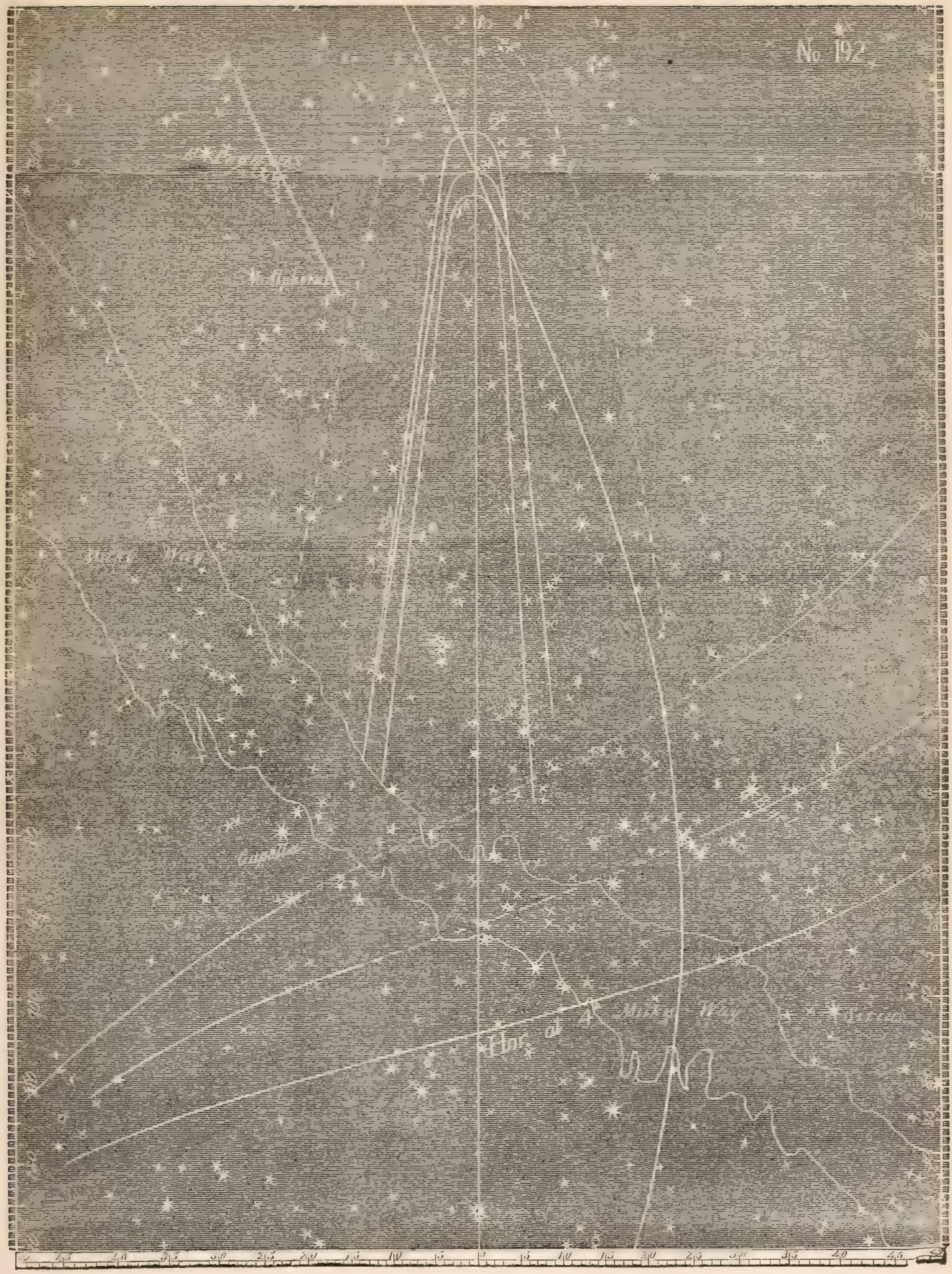

N. Pl
Milky Way
Milky Way
Milky Way

No. 192.

JULY 29th, 1854: Morning.

Lat. at 3*h*., 26° 41′ N.: Lon. 114′ 54′ E.
Sun rose at 5*h* 36*m*.
Stronger and Diffuse Light at 2, 3, and 4 o'clock.

Clouds since last date until this morning, which was tolerably clear. I was up at 1 o'clock, and thought I could distinctly recognize the Zodiacal Light at that very early hour; but did not attempt to get boundaries, on account of clouds flitting by. At 2^h, 3^h, and 4^h, succeeded as per chart. The Zodiacal Light had the same unusual appearance, this morning, that was noticed at the last date; looking as if muddy water had been stirred into it. The stars in its line were either blotted out, or obscured, to an uncommon degree. This morning, as at the last, the atmosphere had a slight degree of haziness.


No. 192
Milky Way
Milky Way
Milky Way

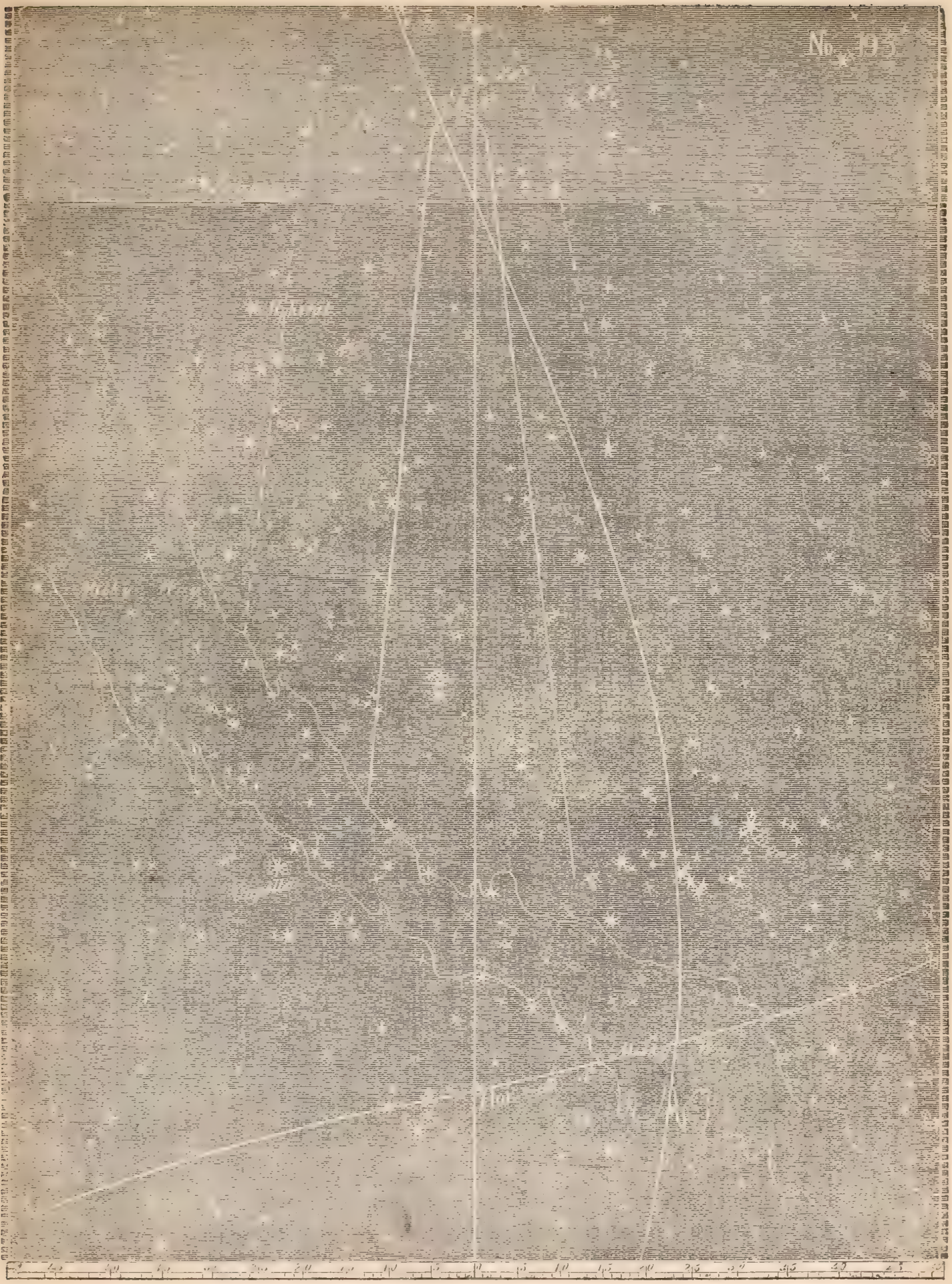
No. 193.

JULY 31st, 1854 : Morning.

Lat. at 3*h*., 19° 29′ N. : Lon. 116° 22′ E.
Sun rose at 5*h*. 39*m*.
Stronger and Diffuse Light at 3 and 4 o'clock.
Sun's Lon. 127° 53′.

The 30th was Sunday. Was not waked till 3 o'clock this morning ; found the sky very clear and bright. No muddiness in the Zodiacal Light. Took boundaries very carefully ; those of the Stronger Light very distinct; of the Diffuse Light, the limits were very badly marked ; and the Light itself was scarcely discernible, except near the Stronger Light. I give its boundaries as they seemed to be, though perhaps they are not fully reliable. The boundaries at 4^h seemed to be the same as at 3 o'clock. In these morning observations I am troubled, while getting the boundaries of the Stronger Light, by what seems to be a rapid varying of the bounds, which can be occasioned only by pulsations ; and I strongly suspect that there are such pulsations, but I am not able to catch them reliably. This morning I was too weak, from sickness,* to observe for them long.

*This sickness, which lasted six months, and is occasionally noticed in these annotations, was not occasioned by exposure in these observations, but by the sun, in my recent visit to Formosa, whither I was sent by the Commodore to make explorations for coal.


No. 1

No. 194.

AUGUST 1st, 1854: Morning.

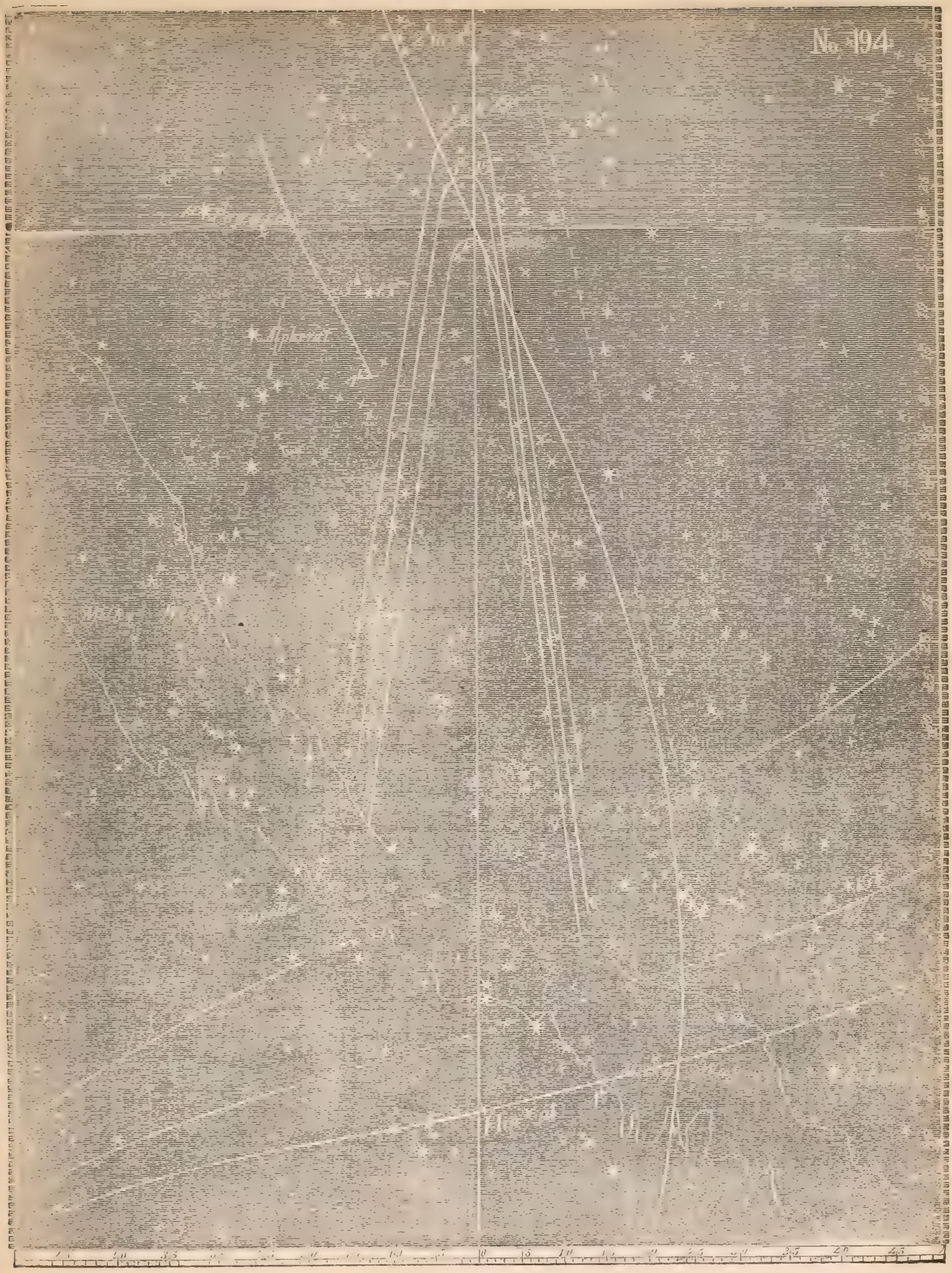
Lat. at 3*h*., 18° 35′ N.: Lon. 119° 32′ E.

Sun rose at 5*h* 41*m*.

Stronger Light { 2*h* 0*m*. / 3 15 / 4 0 } Diffuse at 2 and 4 o'clock.

Sun's Lon. 128° 50′

Was up at 2 o'clock, and found the Zodiacal Light very distinct. Got boundaries easily, except for the Diffuse Light, which was dim at its outer edge. At 3^h, clouds; but sky quite clear and bright from that to dawn. Watched carefully through all the time to see if there were pulsations. Could not be certain, but rather think there were. The difficulty in deciding is now increased by the brilliancy of Venus, and by the Milky Way, which crosses the Zodiacal Light towards its lower end. Have only the space about the Pleiades for observing pulsations; but the width of the Zodiacal Light at that point seems to vary so often and rapidly, as to be accounted for only by pulsations.

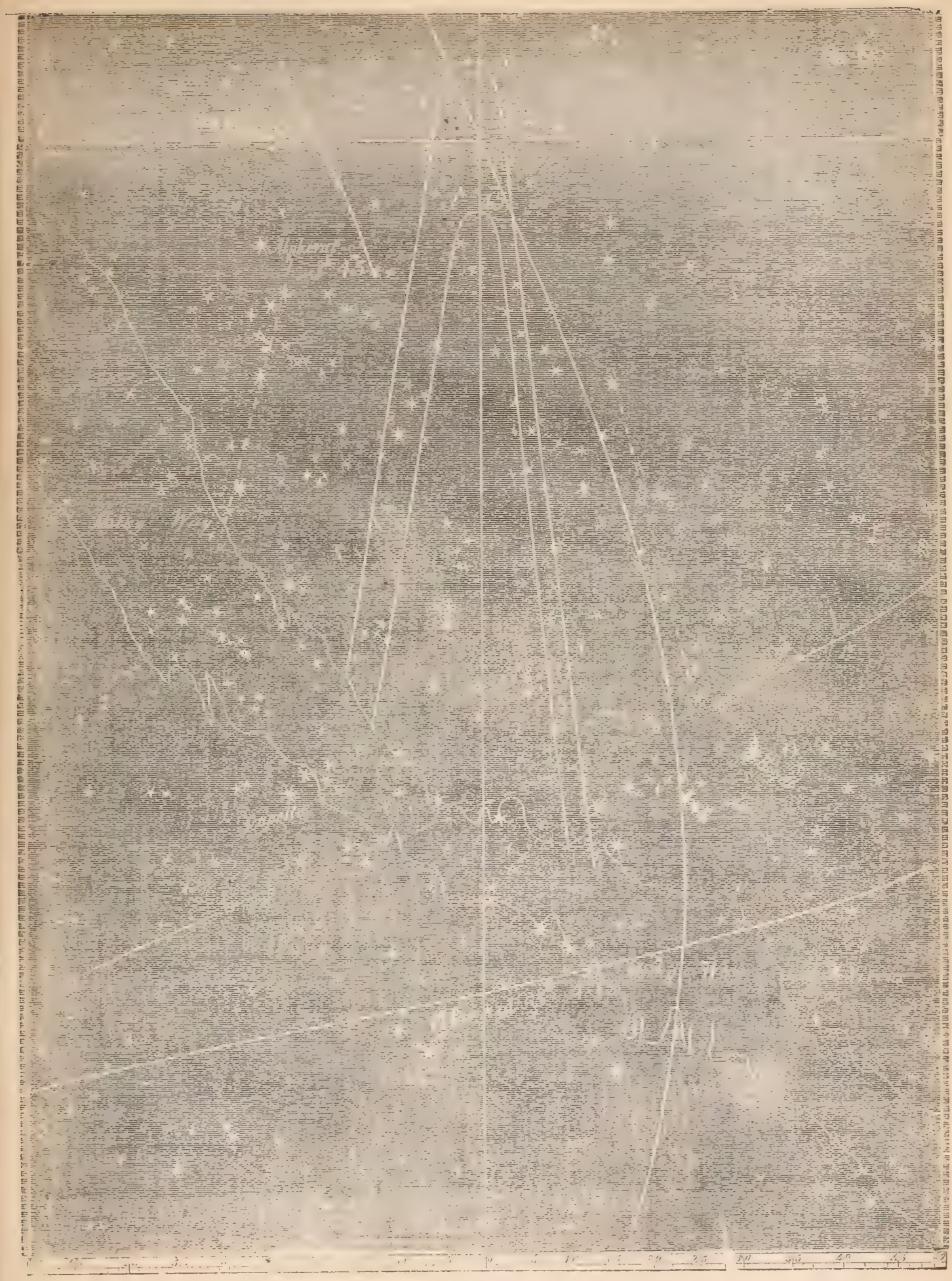

No. 194.

No 185

AUGUST 4th, 1854. Monsiac.

Lat at 3^h, 17° 48′ N : Lon 116° 31′ E.
Sun rose at 5^h 43^m
Stronger Light at 2^h 10^m and 3^h 15^m : Diffuse at 4 o'clock

Clouds since the 1st. Was up at 2 o'clock, and found the Zodiacal Light very distinct—quite bright. Flitting clouds were very troublesome, but, by catching a portion of boundary here and there, as openings occurred, I was able to complete the whole reliably. So, also, at 3^h 45^m. The clouds, however, prevented my getting boundaries of the Diffuse Light, except at its lower end, at 4 o'clock.

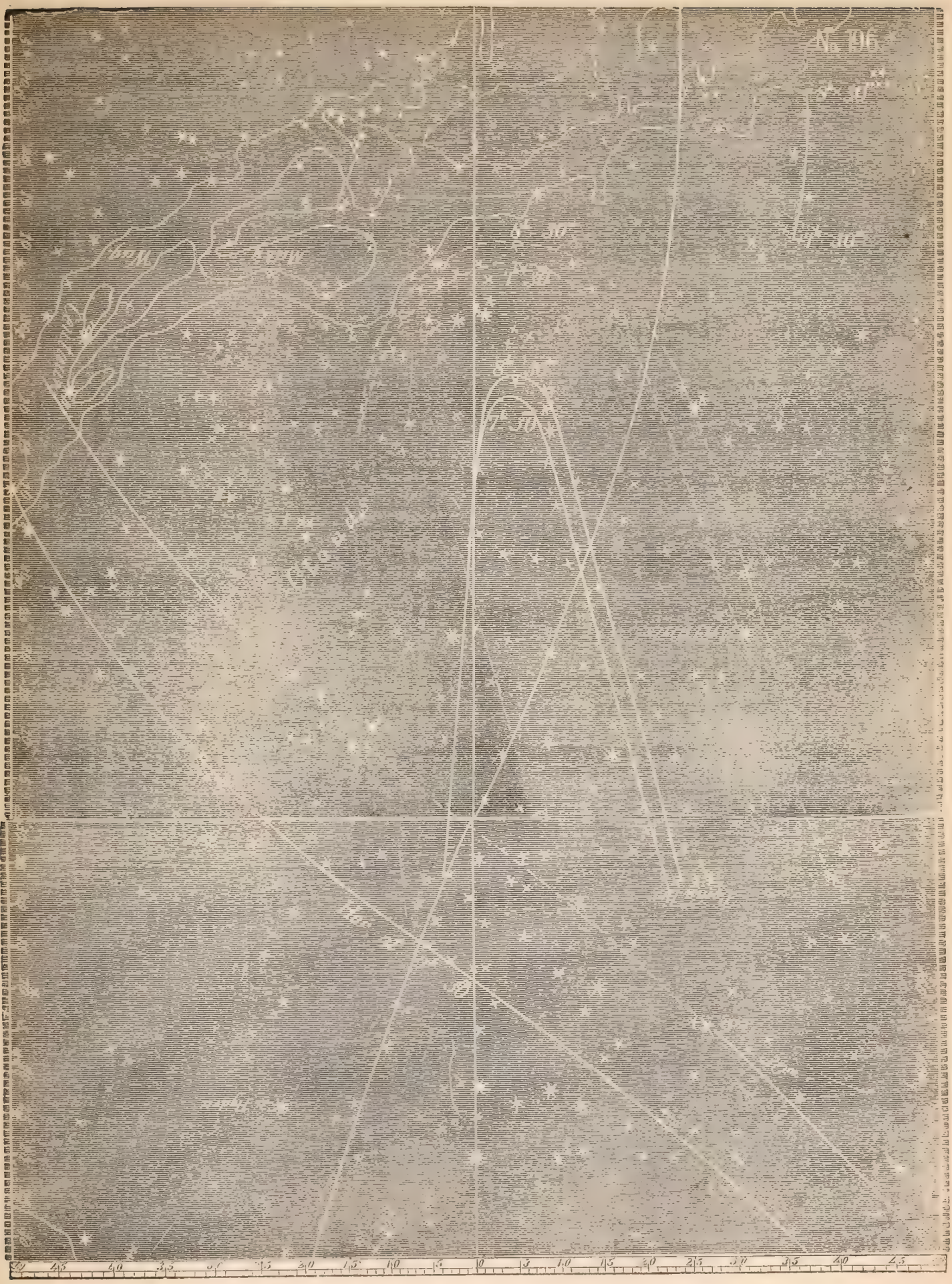


No. 196.

AUGUST 12th, 1854: Evening.*

Lat. 14° 36′ N: Lon. 121° 2′ E.
Sun set at 6*h* 20*m*.
Stronger and Diffuse Light at 7*h*. 30*m*. and 8*h*. 30*m*.

Clouds ever since last date (4th) till this evening, when the sky was pretty favorable for observations, which I had at $7^h\ 30^m$ and $8^h\ 30^m$, as in the chart. The lower end of the Light was shut out from me by houses, but the upper part was distinct.

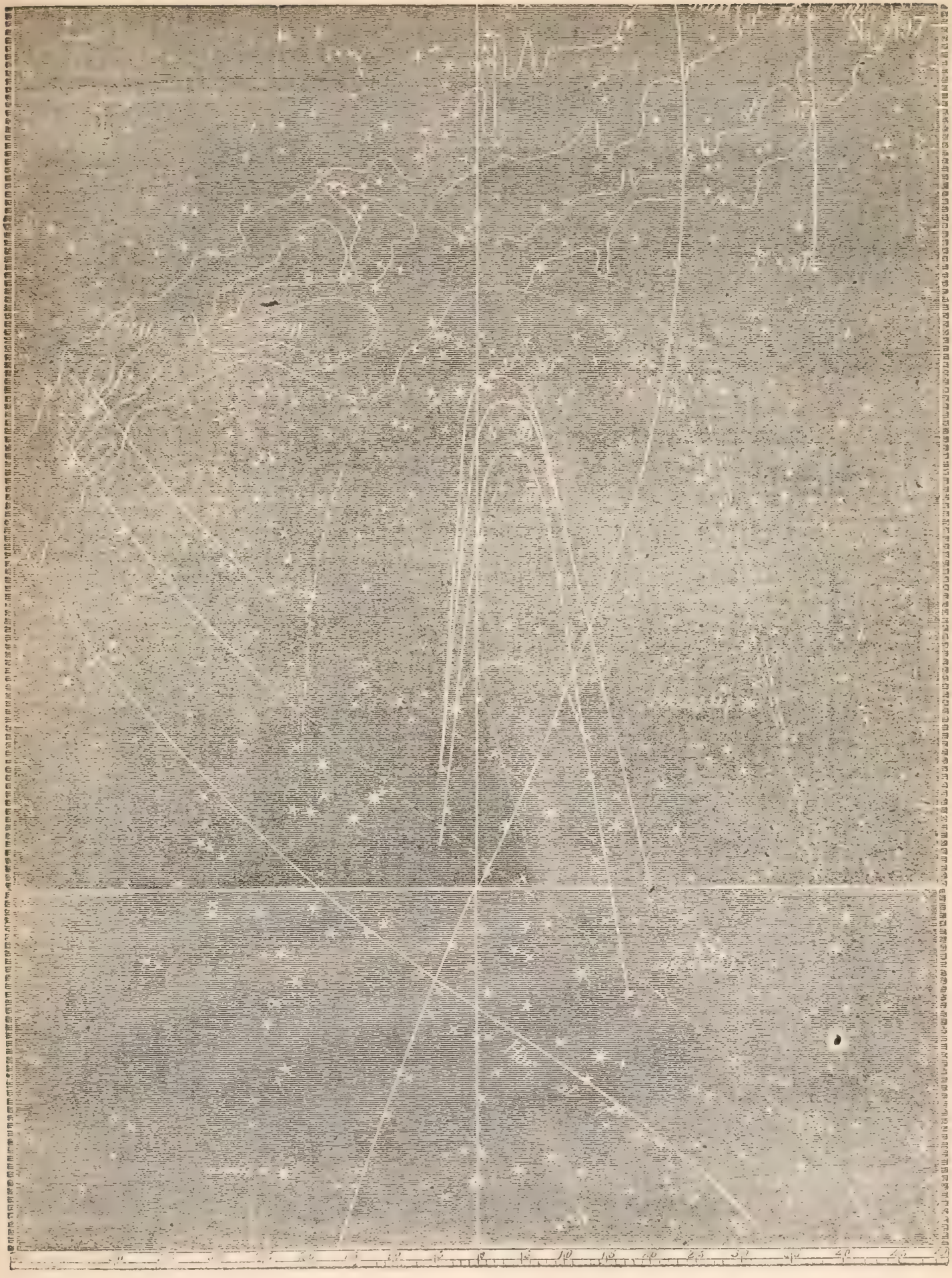


No. 197.

AUGUST 17th, 1854: Evening.

Lat. at 8*h*., 14° 19′ N: Lon. 120° 45′ E
Sun set at 6*h*. 16½*m*.
Stronger and Diffuse Light at { 7*h*. 30*m*. / 8 30 / 9 10

Clouds since last date, until this evening, when the sky was remarkably clear and brilliant. Had a good observation at 7ʰ 30ᵐ: the Light had been distinct 10 or 15 minutes previously, but not sufficiently so to give reliable boundaries. At 7ʰ 30ᵐ, and till 8ʰ, the Stronger Light was very bright, particularly up to the zigzag line; but it also was very decided up to its extreme end. As the ecliptic, in these low latitudes, has risen up considerably in the evening, I watched carefully from 7ʰ 30ᵐ to 9ʰ, to see whether there were pulsations, in either height or intensity; but I could not discover any. At 9ʰ 10ᵐ, the Light was still very distinct and decided. In this latitude the stars sink rapidly; and by 10ʰ, even *Antares* had got well down towards the horizon: I thought the upper end of the Stronger Light could still be made out, extending as far as that star (Antares); but it was difficult to distinguish it now from the usual glare along the horizon.



No. 198.

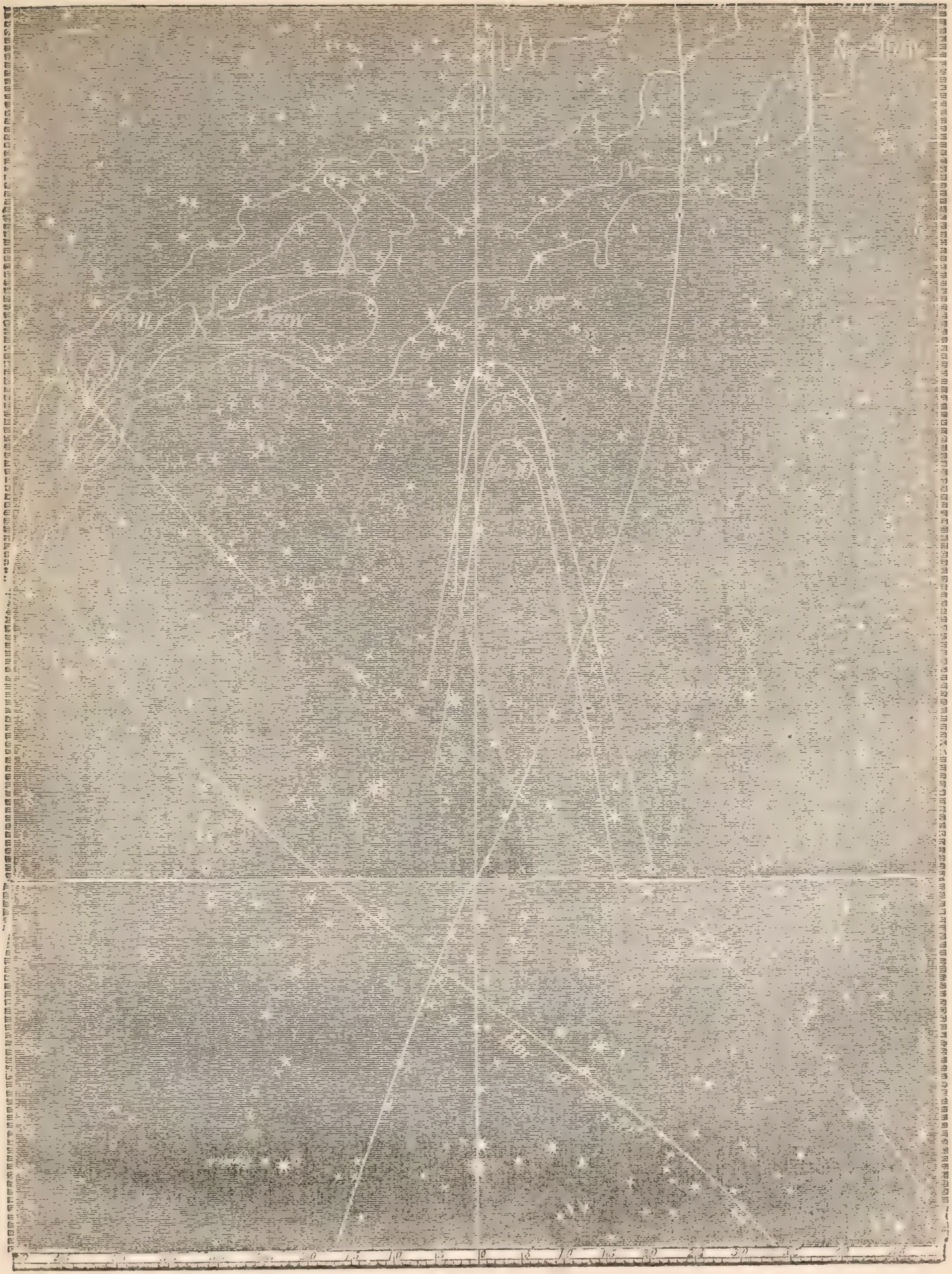
AUGUST 18th, 1874: EVENING.

Lat. at 8*h*., 14° 23′ N.: Lon. 119° 52′ E.

Sun set 6*h* 17*m*.

Stronger Light at { 7*h* 30*m* / 8 0 / 9 0 / 9 30 } Diffuse, 7*h*. 30*m*.

Sky not at the brightest; but I was able to get reliable observations at the times noted in the chart. Tried again, very carefully and repeatedly, from $9^h\ 30^m$ to $9^h\ 40^m$, to get boundaries; but, though the sky was now favorable, I could not succeed. The Stronger Light was yet distinctly to be seen, and seemed to have travelled up as far as just above Antares (as marked by dotted lines); but I could not determine this with certainty.



No. 199.

AUGUST 21st, 1854: Morning.

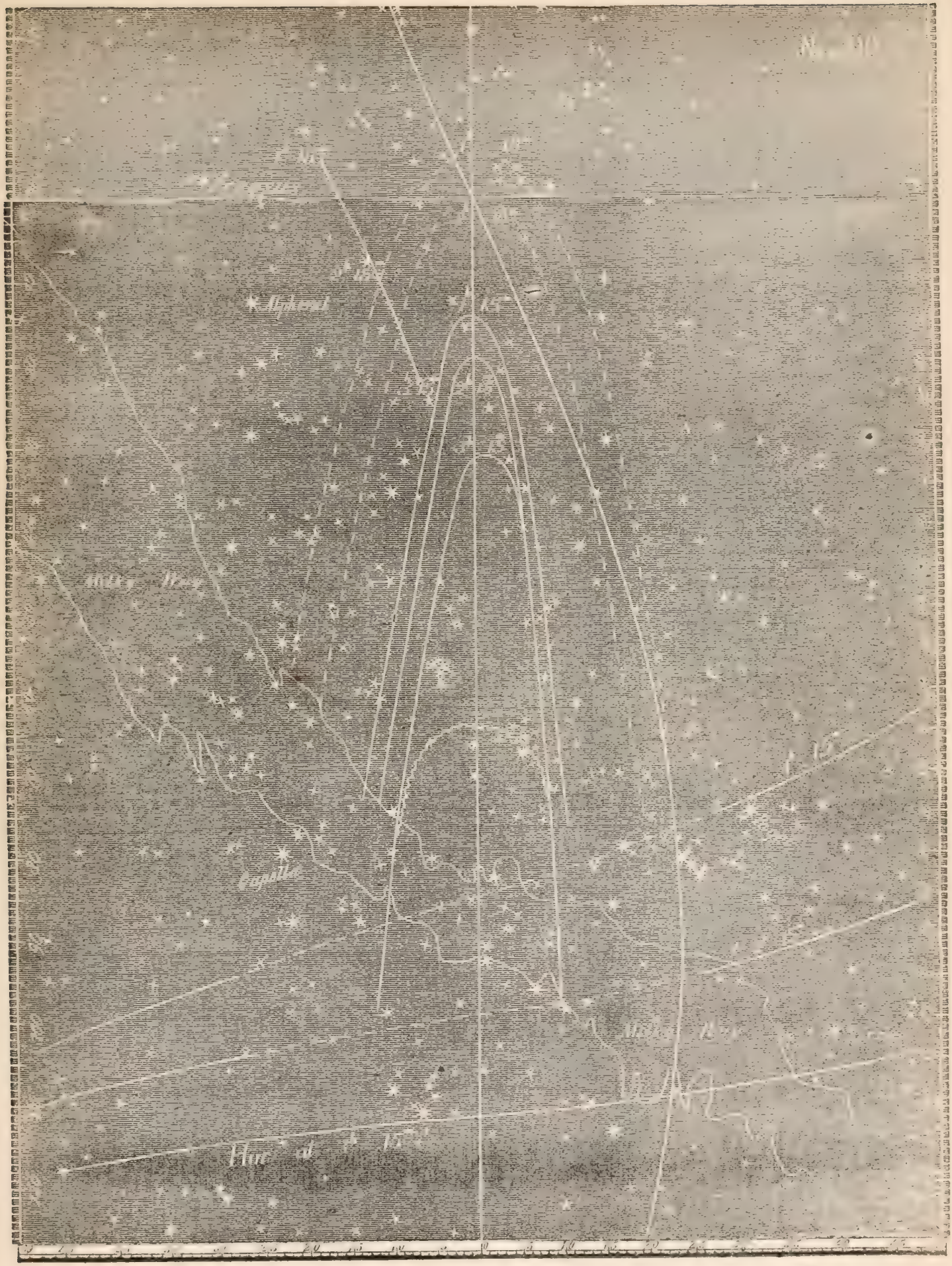
Lat at 3*h*., 14° 27′ N.: Lon. 117° 16 E.

Sun rose at 5*h*. 50*m*.

Stronger Light at { 1*h* 15*m*. / 2 15 / 3 15 } Diffuse 1*h*. 15*m*. and 2*h*. 15.

Sun's Lon. 148° 3′.

(19th, clouds; 20th, Sunday). Was up this morning at 1 o'clock, and found the Zodiacal Light quite distinct, but not giving very well marked boundaries. Some passing clouds interfered: I got boundaries at $1^h\ 15^m$, which I believe may be relied on; also at $2^h\ 15^m$ and $3^h\ 15^m$. At the last observation, the lower end of the Stronger Light, as high as the zigzag, was brighter than the rest, to such a striking degree that I noted it on the chart. The sky, this morning, was remarkably brilliant, and favorable for observations.

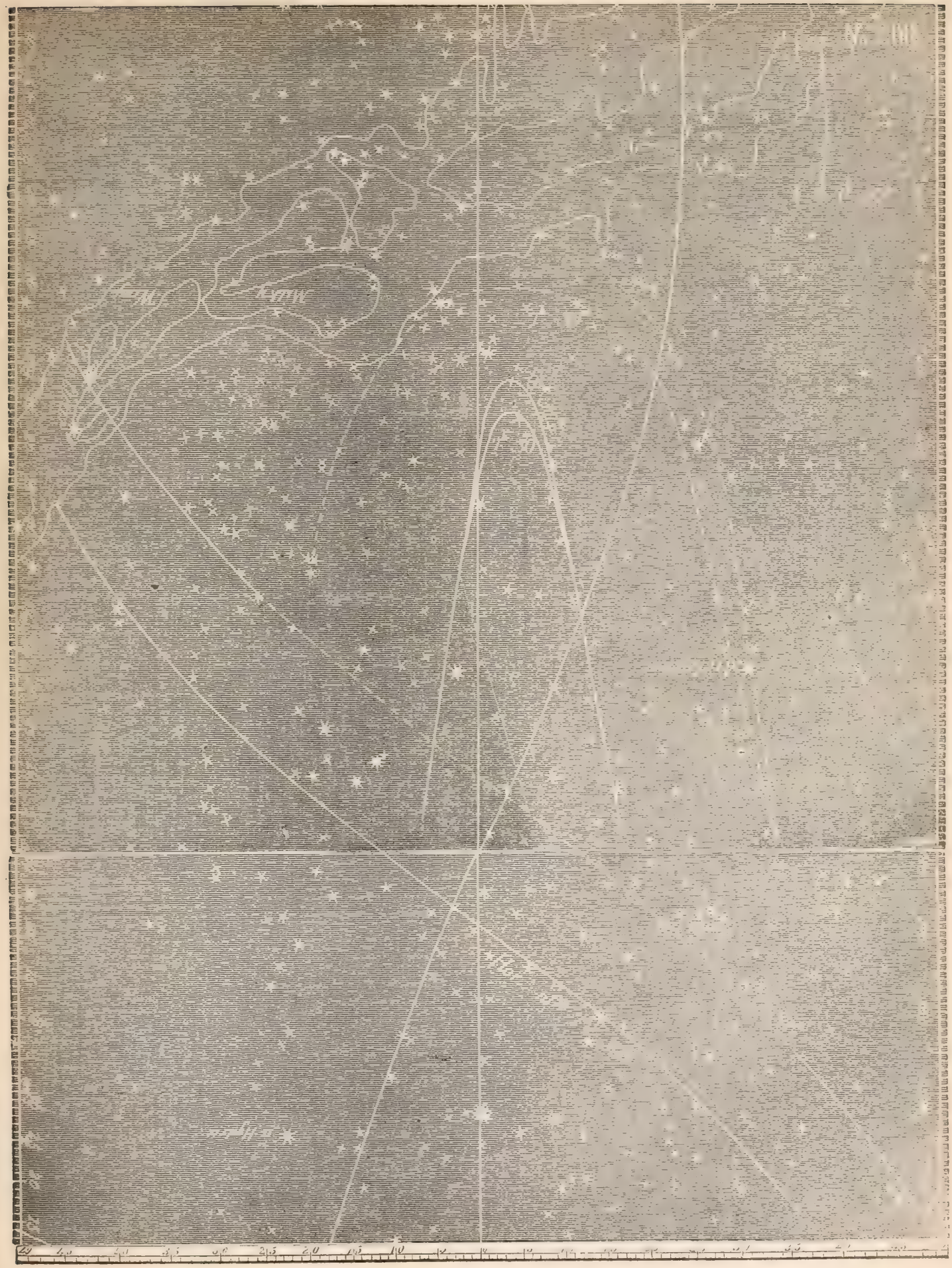

Algieba
Regulus
Leo Minor
Coma Berenices

No. 200.

AUGUST 21st, 1854: EVENING.

Lat. at 8^h, 14° 44′ N: Lon. 117° 12′ E.
Sun set $6^h.\ 16^m.$
Stronger and Diffuse Light at $7^h.\ 30^m.$ and $8^h.\ 30^m.$

The sky tolerably clear and good. In the observation at $7^h\ 30^m$, I took particular pains with reference to the divergence of the lower limit of the Stronger Light, from a parallelism with the ecliptic. At $8^h\ 30^m$, the Light had already become dimmed considerably, and much of its lower portion had descended below the horizon. At $9^h\ 30^m$, only a slight general brightness could be seen between 9 Scorpionis and the horizon; and, though I tried carefully, no reliable boundaries could be made out.



No. 201.

AUGUST 22d, 1854 : Morning.

Lat. at 3*h*., 14° 46′ N. : Lon. 117° 11′ E.

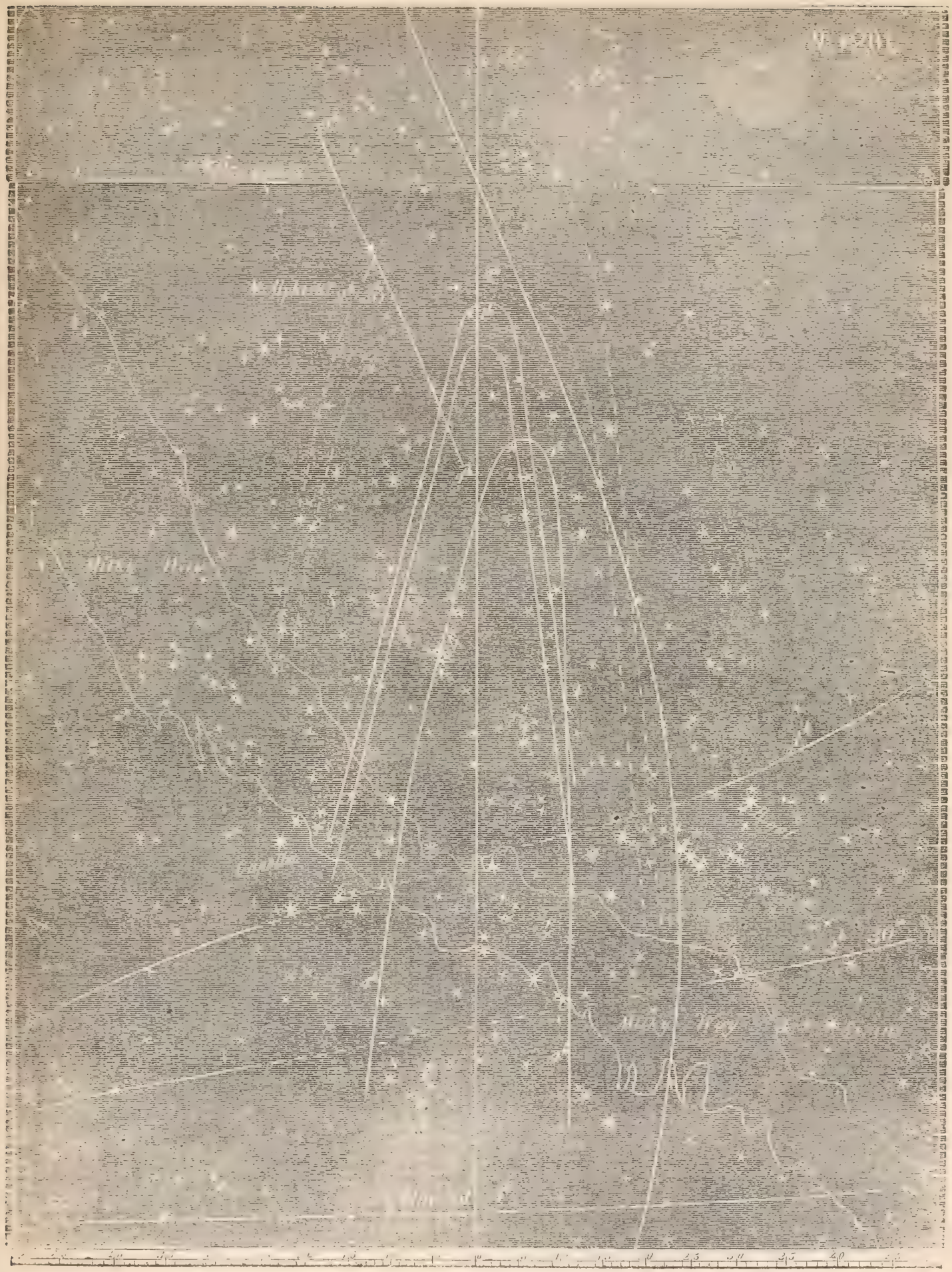
Sun rose at 5*h*. 50*m*.

Stronger Light at { 1*h*. 0*m*. / 2 30 / 4 0 } Diffuse 1*h*. and 4*h*.

Sun's Lon. 145°.

Was up at 1 o'clock, and found the Zodiacal Light quite distinctly marked ; the sky being very clear and favorable for observations. At 2^h 30^m, the Diffuse apparently as before, but it was very dim, especially at its upper end. The sliding over of the Stronger Light, as seen at 4^h, is very remarkable, and I must give further attention to it ; it was so singular, that I did not enter the boundaries of this hour on the chart until after long and very careful observations. I had noticed also, at 2^h 30^m, that the Light had concentrated much; *i. e.* was much brighter towards the lower edge, or right-hand boundary given for that time. There was no great change in the angle of the horizon, to account for this sliding over at 4^h. The Diffuse Light was very dim this morning, except at its lower end.

[1856. I had not then thought of drawing the zenith lines, and I did not think of this till long after the above date. They will account for the great sliding over of the boundary-lines of the Zodiacal Light.]



No. 202.

AUGUST 22d, 1854: EVENING.

Lat. at 8*h*., 15° 45′ N.: Lon. 116° 36′ E.
Sun set 6*h*. 16*m*.
Stronger Light at 7*h*. 30*m*., &c., to 9*h*.: Diffuse 7*h*. 30*m*. and 8*h*. 30*m*.

Evening very bright and clear, and favorable for observations. At $7^h\ 30^m$, got boundaries as at *a a*—strongest below the zigzag line. The Light began to show itself somewhat suddenly at about $7^h\ 20^m$, but did not give reliable boundaries till at the time noted above. After $7^h\ 30^m$, I was watching the Light—not, however, in the slightest degree expecting pulsations, the ecliptic being then low towards the horizon—when I began to suspect that there were sudden changes, both in the intensity and limits of the Stronger Light, especially in the former. I soon became so well satisfied of such pulsations, that I began to take notes of the succeeding ones, which are as follows:

h. *m*.
* * * *

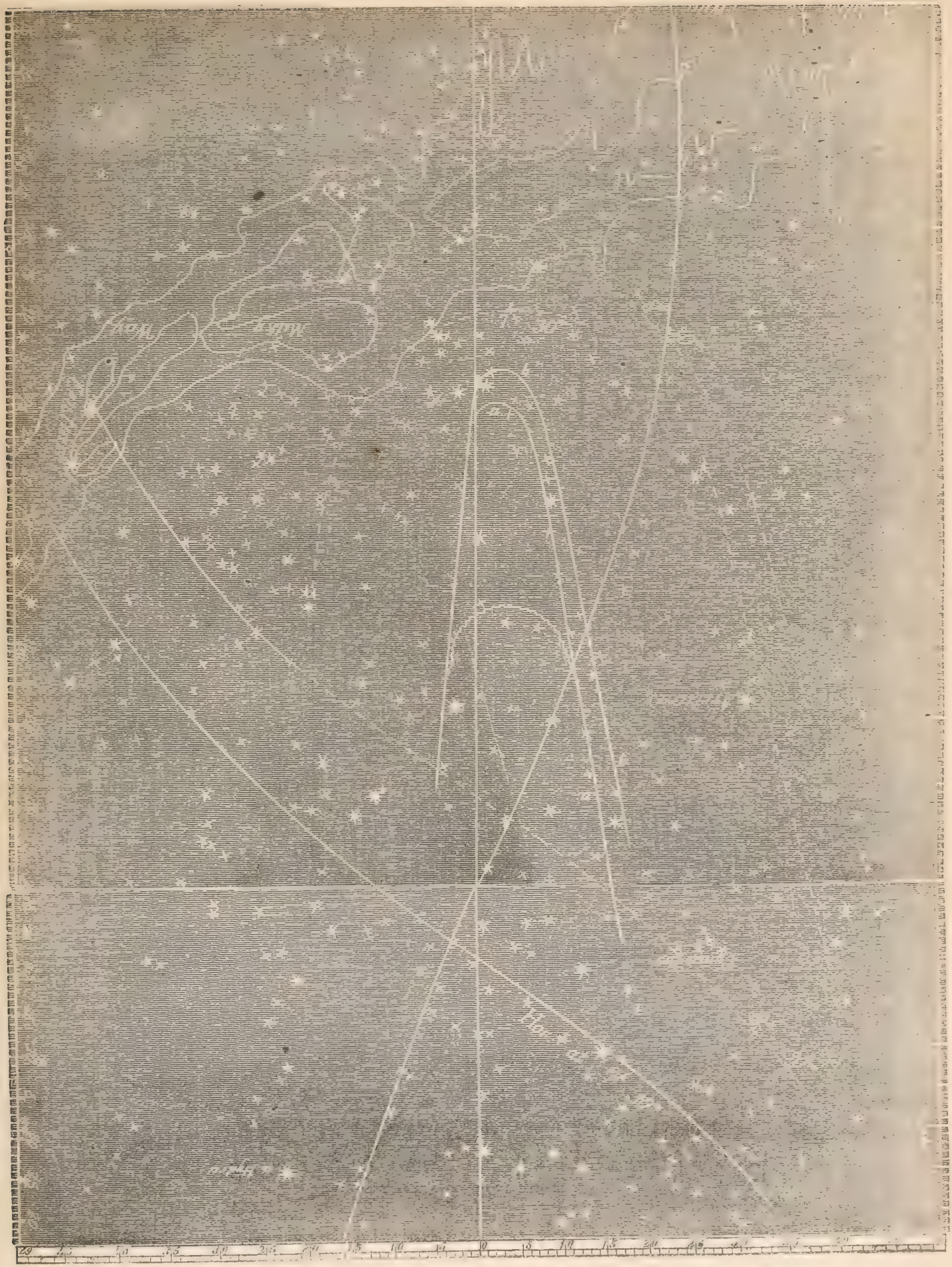
At 7 52½, dim—boundary as at *a a*.
7 53½, brightening.
7 54⅔, bright—boundary as at *b b*.
7 56, dimming.
7 57, quite dim, boundary as at *a a*.
(There is no mistake on the subject.)
7 58, brightening.
7 59, do. slowly.

} I think there can be no doubt about these.

At $8^h\ 30^m$, still at *b b*; still tolerably bright.

h. *m*.
At 8 0, tolerably bright.
8 3½, there still seem to be pulsations; but they are so slight, I cannot get them confidently.
8 6, bright, and at *b b*.
8 8½, do. do.
8 10, do. do.
Seemed to continue permanent in this brightness, and at *b b*.

At 9^h, the Light still observable, but the boundaries could no longer be made out in a reliable manner.



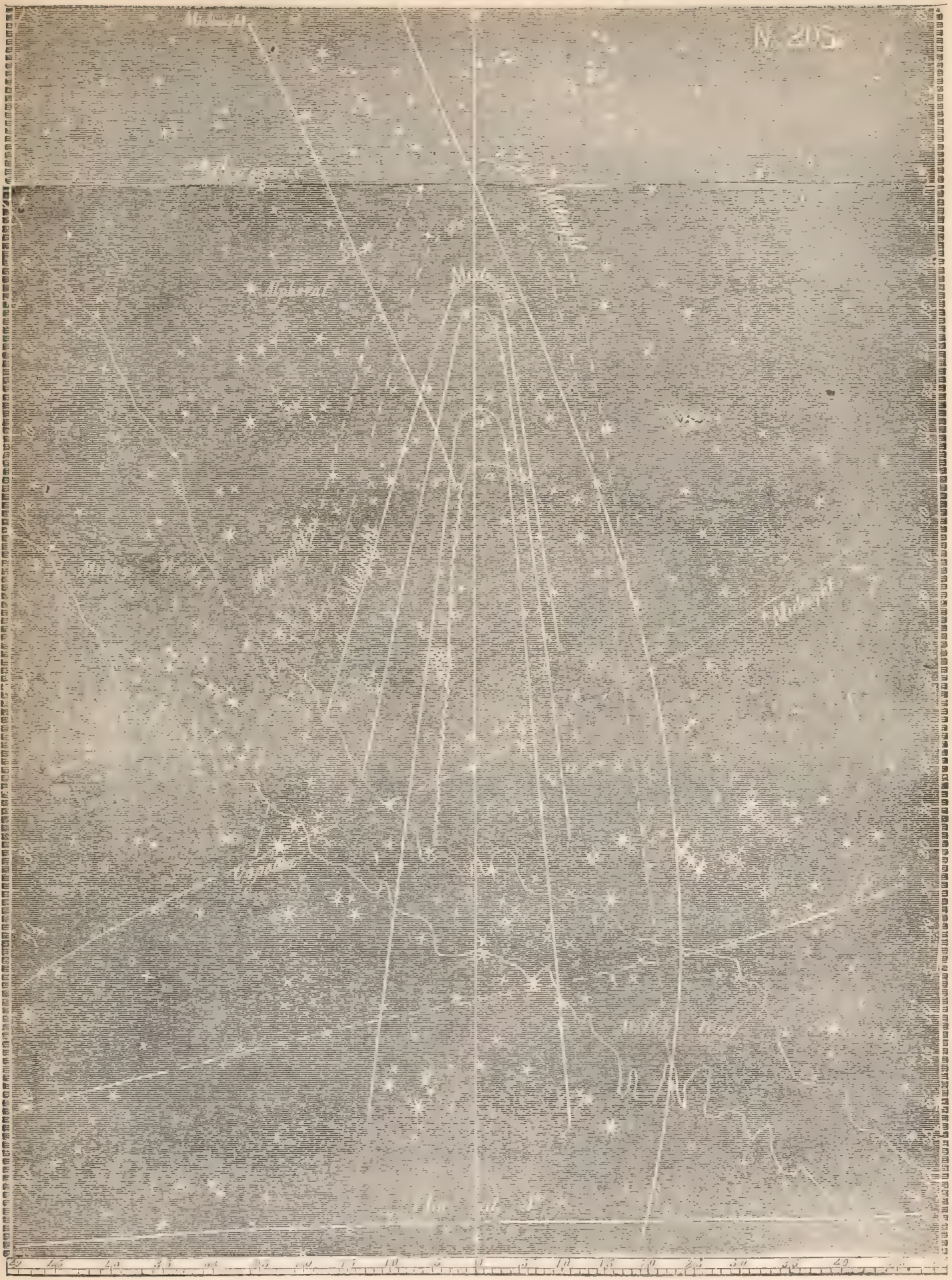
No. 203.

AUGUST 23d, 1854: Morning.

Lat., at 3*h*., 16° 0′ N.: Lon. 116° 26′ E.
Sun rose at 5*h*. 49*m*.
Stronger Light at midnight, 2*h*. and 4*h*.: Diffuse at midnight and 4 o'clock.
Sun's Lon. 149° 58′.

I wished to see at how early a time the eastern Zodiacal Light would show itself, and went on deck at midnight; but the Zodiacal Light had even then got the start of me, and was quite distinctly displayed. I took boundaries of it, as given in the chart; also, at 2 and 4 o'clock. At 2*h*, though the Stronger Light may be said to have its limits as marked for that hour, there was a much brighter part of it within the limits of the zigzag *a a a*—the same as is referred to in yesterday morning's record. But there was no sliding over of the Light this morning, as mapped yesterday.* It is, indeed, difficult to say where the outlines of the Stronger Light are, for, from that brightness within *a a a*, it dims off rather gradually till we reach the outer limits of the Diffuse Light; and these are now so indistinctly marked in the morning sky, that I sometimes hesitate about marking the boundaries of the Diffuse at all; but, though somewhat doubtful toward their upper end, they are not so at the lower; and, by taking these to assist as my guide along the sky, I made out to complete them as given in the chart.

* 1856. A closer reference to the chart will show that there was, to some degree, though it was not so striking as on the 22d.

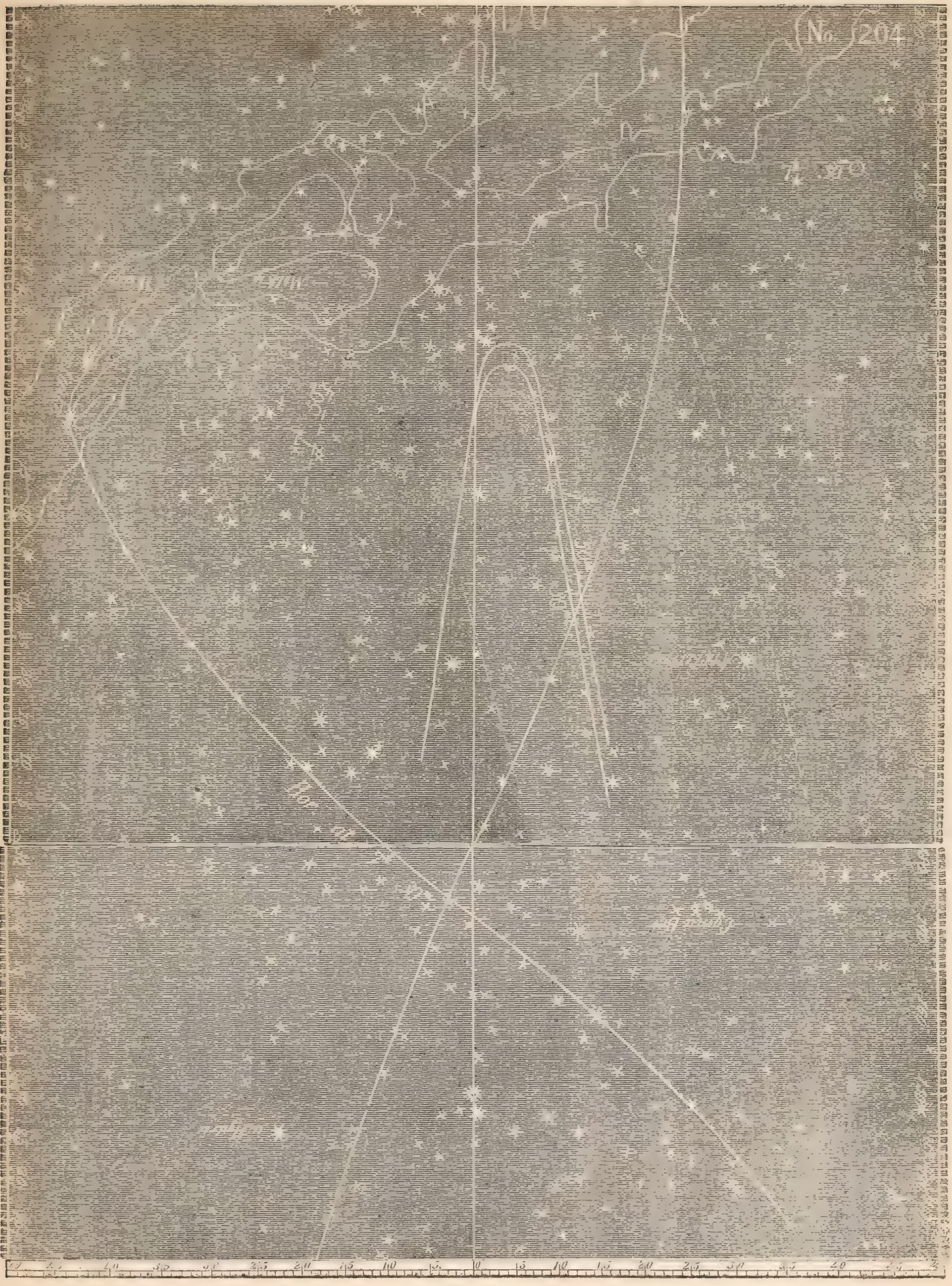

N. 205
Aldebaran
Algol
Capella
Procyon
Sirius
Rigel

No. 204.

AUGUST 23d, 1854: Evening.

Lat., at 8*h*., 17° 59′ N.: Lon. 115° 42′ E.
Sun set at 6*h*. 17½*m*.
Stronger Light at 7*h*. 30*m*. and 7*h*. 50*m*: Diffuse at 7*h*. 50*m*.

Sky not favorable; a haziness along the horizon, and also passing clouds. I commenced getting snatches of boundary-lines at $7^h\ 30^m$, and finally completed them. After $7^h\ 50^m$, clouds came up, and, with the haziness, prevented further observations. The same cause prevented my seeing pulsations, if there were any.

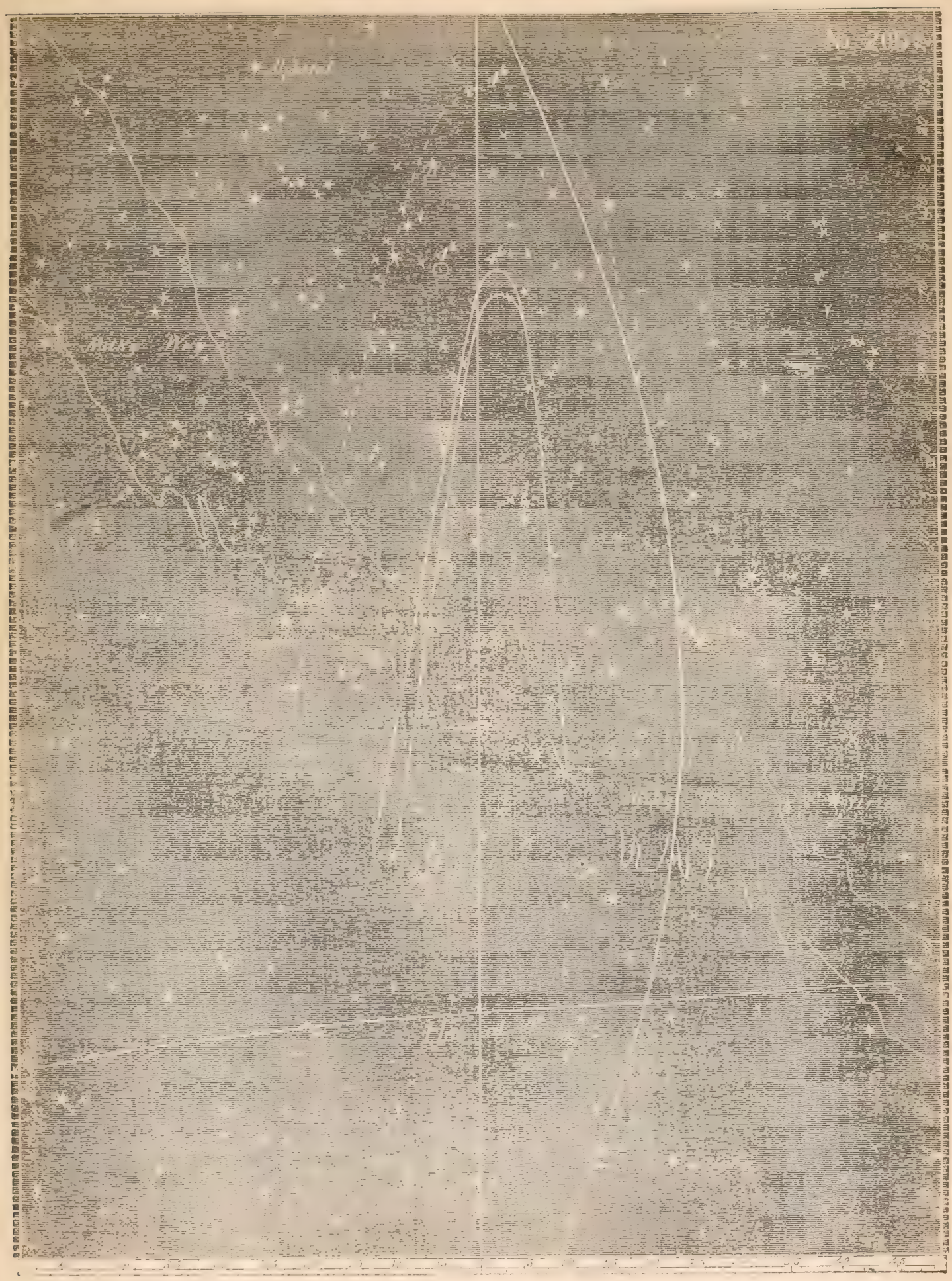

No. 204

No. 205.

AUGUST 24th, 1854: Morning.

Lat at 4*h*., 15° 36′ N.: Lon. 115° 26′ E.
Sun rose at 5*h*. 47½*m*.
Stronger Light at 4*h*. and 4*h*. 3*m*.: Diffuse at 4*h*.

The orderly at the cabin-door forgot to wake me as directed; and, in consequence of the loss of sleep for several nights previous, I did not awake of myself until 4 o'clock. The morning, however, was not very favorable, the sky being troubled by flitting clouds. I have neglected yet to mention that, while the evening Zodiacal Light is much shorter than the morning, its upper boundaries are far more distinctly marked, and particularly its apex.



No. 206.

AUGUST 25th, 1851: EVENING.

Lat. at 8*h*., 20° 47′ N : Lon. 114° 32′ E.

Sun set at 6*h*. 19*m*.

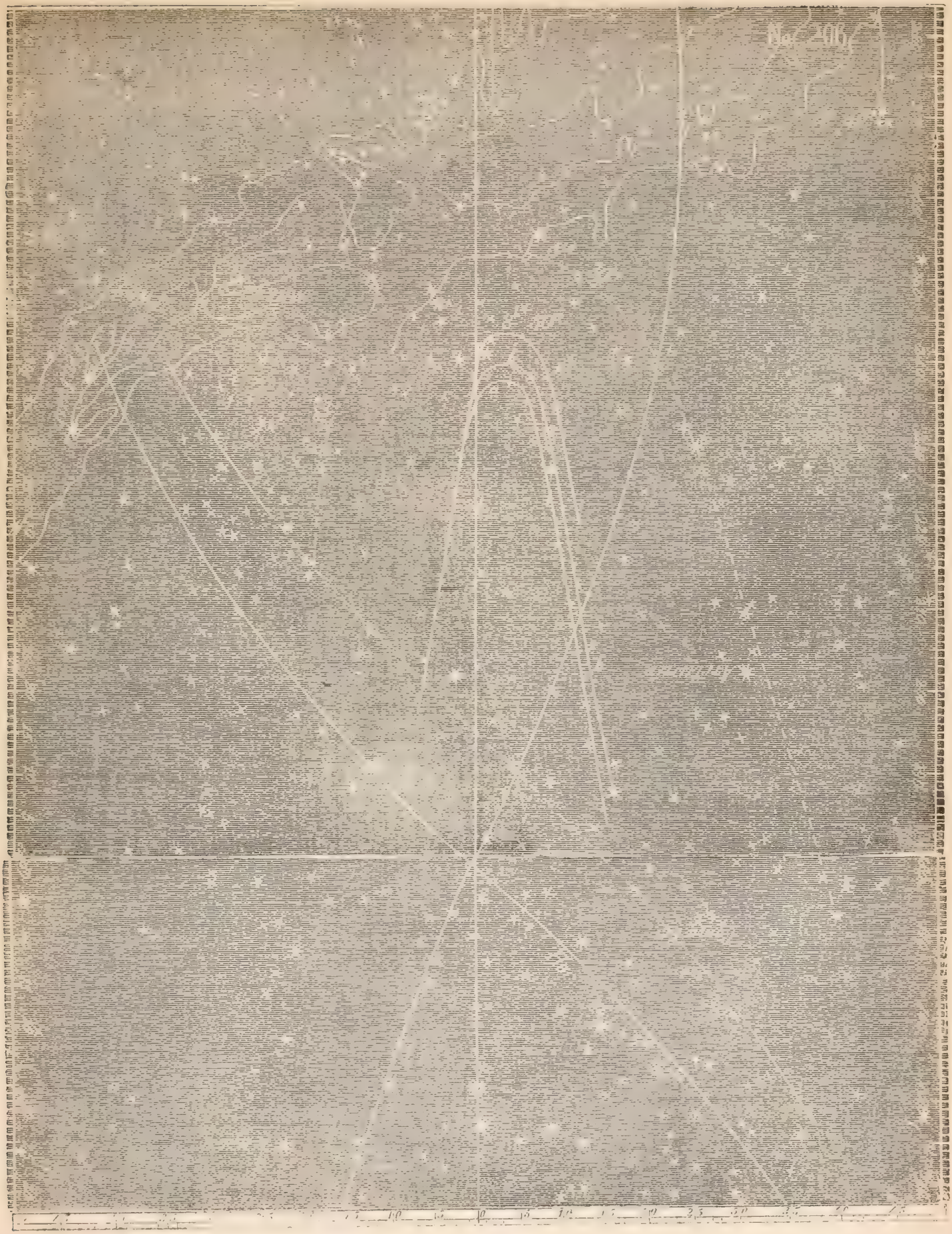
Stronger Light at { 7*h*. 42*m*. / 8 30 } Diffuse Light at 8*h*. 30*m*.

Clouds since yesterday a. m. until this evening. Was prevented by the same cause, on this occasion, till $7^h\ 42^m$, when, the clouds leaving the sky very favorable, except quite at the horizon, I had a good observation, and looked carefully to see if there were pulsations. The records I took at the time are as follows: $7^h\ 42^m$ being at *a a*, as in the chart.

h. *m*.		*h*. *m*.	
At 7 47,	at *b*, and bright.	At 7 54,	quite bright, and at *b*.
7 49,	at *a*, and dim.	7 55½,	do. do. do.
7 50½,	at *b*, and bright.	8 0,	at *b*, and not so bright.
to 7 53,	at do. do.	8 0⅔,	do. and bright; and so it remained.

I offer these notes of changes, however, with hesitation, inasmuch as these apparent changes were not clear and decided, and of a fully satisfactory character. I give them as what they seemed to me to be.

At $8^h\ 30^m$ the sky was quite brilliant; at $9^h\ 30^m$ the boundaries were apparently the same as at last observation. The Light was quite perceptible, but was, however, very dim at this hour. I had an observation of the eastern Zodiacal Light at 11 *o'clock* (for which see next morning's entry—26th).



No. 207.

AUGUST 26th, 1854: Morning.

Lat. at 3*h*.. 21° 0′ N.: Lon. 114° 18′ E.

Sun rose at 5*h*. 45*m*.

Stronger Light at { 11*h*. of 25th / 3 of 26th / 4 } Diffuse, 2*h*. 0*m*. and 4*h*. 0*m*.

Sun's Lon. 152° 50′: Zenith point at 11*h*. p. m. of 25th: Lat. 34° 15′ N.: Lon. 332° 30′.

Sky very clear and brilliant. I was anxious to see at what time the earliest certain exhibition of Zodiacal Light in the east could be made out, and looked carefully in that quarter at 10^h last evening; but nothing of it could be recognized. At 11 o'clock, went again on deck; and now the eastern Zodiacal Light was very apparent and decided. Lieutenant P——— had charge of the deck at that hour; and on his coming over to where I was observing, I directed his attention to that part of the sky, and asked him whether he could distinguish the Zodiacal Light. He answered, "Oh yes, I can see it very plainly." The sky was very fine for observations. The intensity of the Light about 48, 57, and 58 Tauri was at 11^h 15^m equal to that of the Milky Way at 27 and 13 Persei, or anywhere between Algol and 33 Persei. (For morning observations, see chart.) The Zodiacal Light at 3^h and 4^h is now extremely brilliant; but the several parts melt away so gradually, that it is difficult to get boundaries except at the lower end.

No. 203.

AUGUST 28th, 1854: Morning.

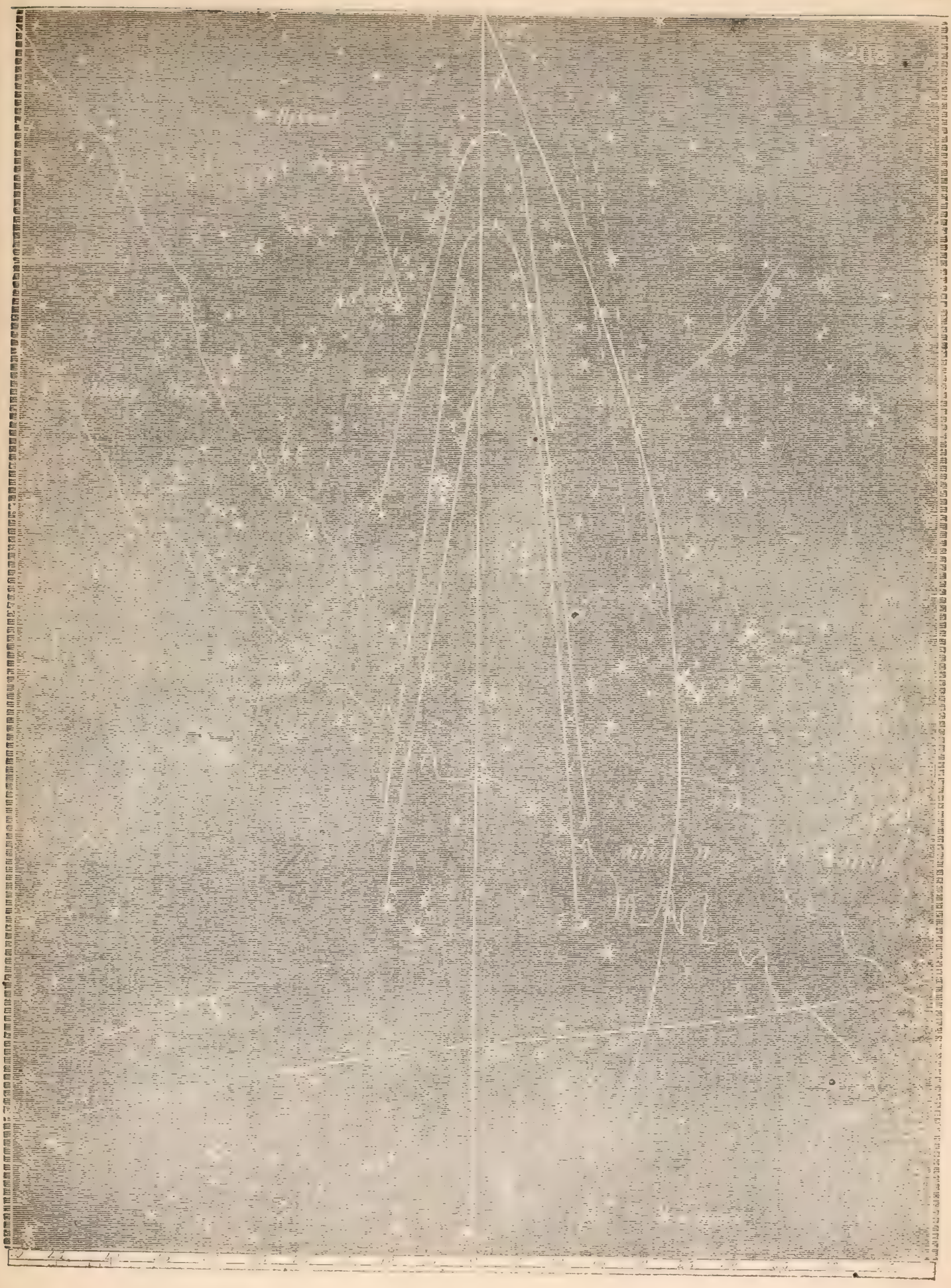
Lat. 22° 18′ N : Lon. 114° 10′ E.

Sun rose at 5*h*. 45*m*.

Stronger Light at { 11*h*. 30*m*. of 27th / 2 30 of 28th / 3 30 " } Diffuse, 2*h*. 30*m*. and 4*h*. 0*m*.

Sun's Lon. 154° 4′.

27th was Sunday. Had observations, this morning, as in the chart. Sky clear and good; and the Zodiacal Light quite distinct in the east at 11 o'clock.

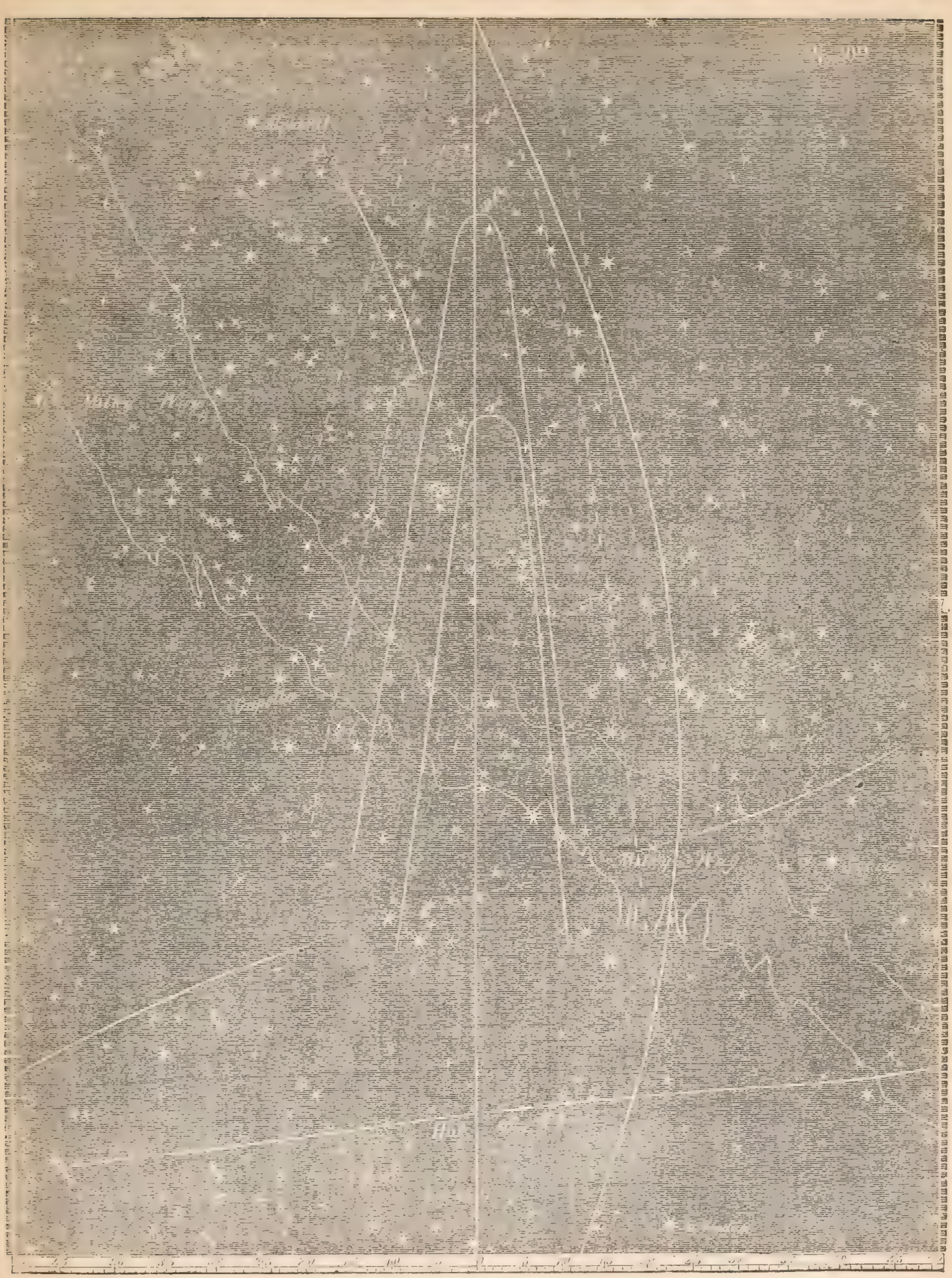


No. 209.

AUGUST 29th, 1854: Morning.

Lat. 22° 18′ N.: Lon. 114° 10′ E.
Sun rose at 5*h*. 45*m*.
Stronger and Diffuse Light at 2 and 4 o'clock.
Sun's lon. 155° 44′.

Sky in the evening dull: towards morning, very clear and bright. Got observations at 2 and 4 o'clock. The upper termination of the Diffuse Light is very uncertain: and I am guided, in drawing it, chiefly by the convergence of the lines as seen lower down. Its track (*i. e.*, of the Diffuse Light) across the Milky Way is now evident. I looked to see whether there might be pulsations; but if there are any, the Milky Way, crossing the zodiacal path below, would make it difficult to detect them.



No. 210.

AUGUST 31st, 1854: MORNING.

Lat. 22° 18′ N.: Lon. 114° 10′ E.

Sun rose at 5*h*. 45*m*.

Stronger Light at { 11*h*. 30*m*. of 30th / 1 15 of 31st / 2 45 } Diffuse 1*h*. 15*m*.

Sun's Lon. 157° 42′.

Clouds since my last date. Clear this night till towards morning. At $11^h\ 30^m$ could easily make out boundaries of Stronger Light in the east, and could see the Diffuse Light; but the latter was too dim to give reliable bounds. Did not wake, after $2^h\ 30^m$, till towards dawn, when clouds prevented any observation.

No. 211.

SEPTEMBER 4th, 1854: Morning.

Lat. 22° 18′ N.: Lon. 114° 10′ E.

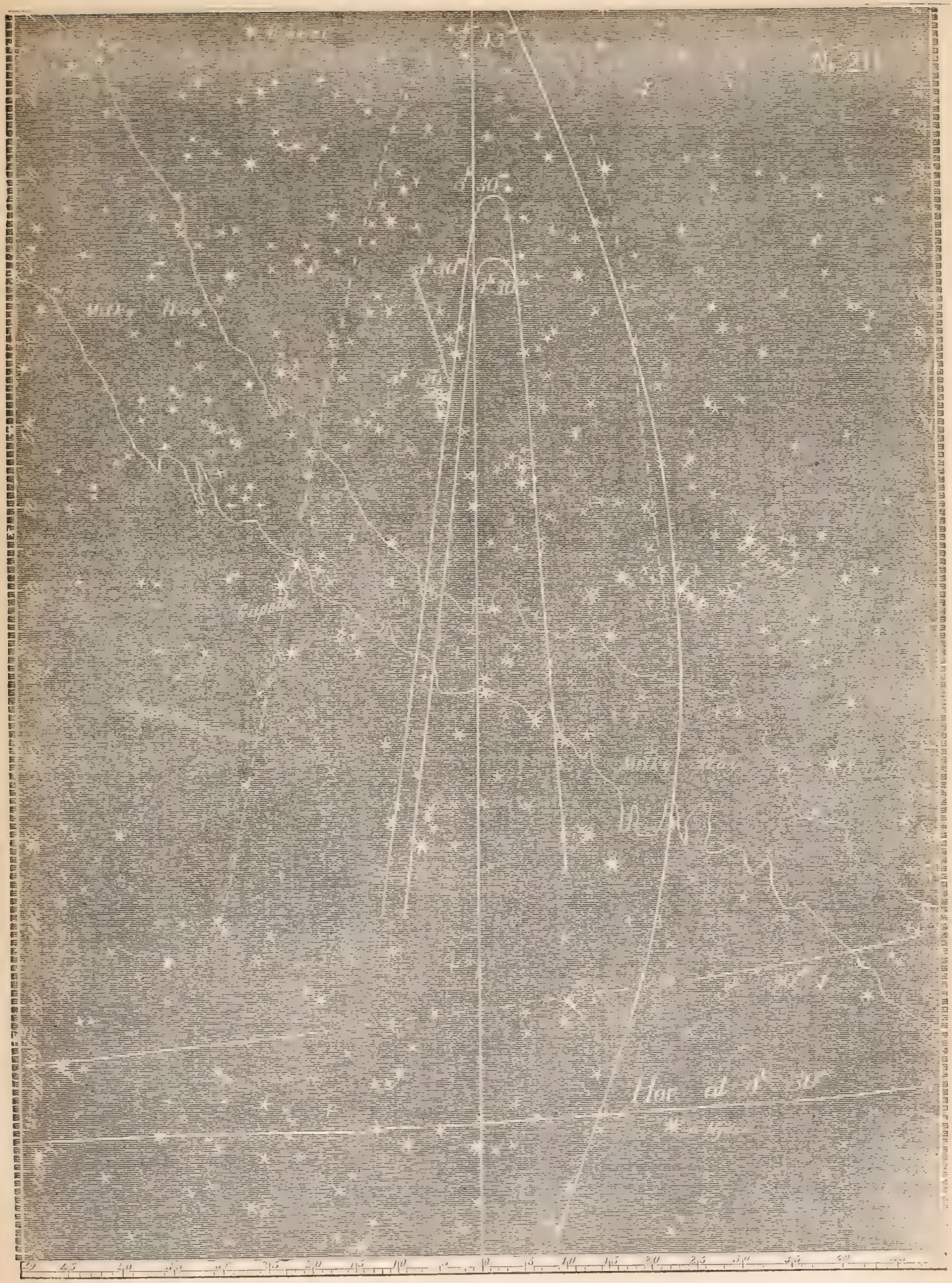
Sun rose at 5*h*. 48*m*.

Stronger Light at { 3*h*. 30*m*. / 4 30 } Diffuse at 3*h*. 45*m*.

Sun's Lon. 161° 35′.

Clouds since my last date, until this morning. Moon set about 3^{h} 30^{m}, when I obtained an observation. The sky was bright, and the Stronger Zodiacal Light quite so, especially up as high as the Milky Way. I watched for an hour, to see whether there were pulsations. Sometimes felt pretty certain that there were such, in *intensity* of the Light; and two or three times, made records of such apparent changes; but I cannot speak of them reliably, and therefore omit them here.

Dawn about 4^{h} 38^{m}.



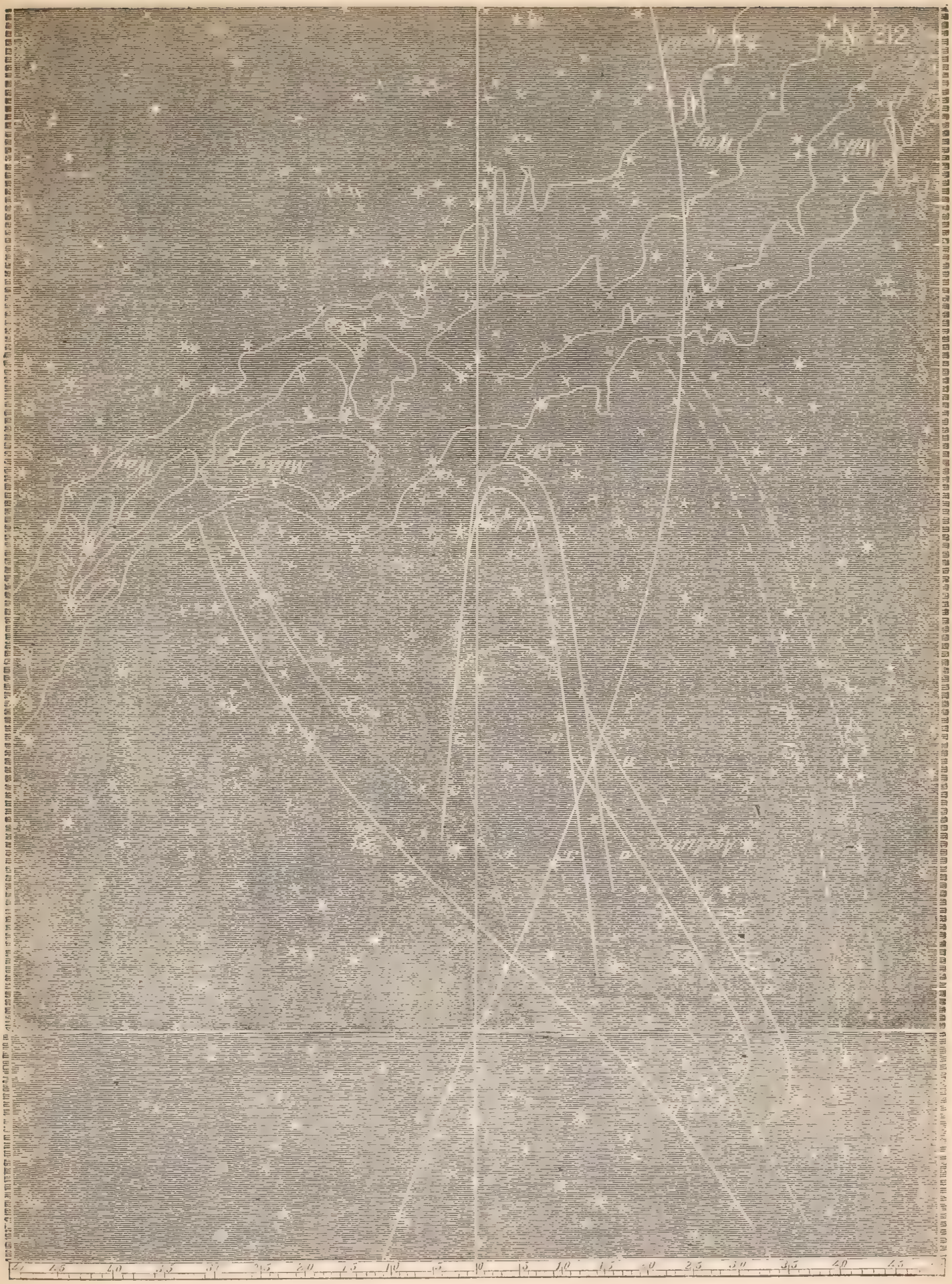
No. 212.

SEPTEMBER 12th, 1854: Evening.

Lat. at 7^h 30^m., 22° 15′ N.: Lon. 115° 4′ E.
Sun set 6^h. 2^m.
Stronger and Diffuse Light at 7^h. 15^m. and 7^h. 45^m.

Clouds ever since last observation (September 4th), until this evening: sky, to-night, very clear and brilliant. The Zodiacal Light quite distinct. The ecliptic has got down to a low angle with the horizon; and there was, this evening, a slanting off of the Stronger Light, as in the line $a\ a$, in the chart. This Light off to $d\ d$, was, I think, decidedly Zodiacal; for there was no such Light along the horizon, on either side of $d\ d$, or $c\ c$; it terminating abruptly at both places, and at d by a sudden curve towards the horizon. While this Light between $b\ b$, and $a\ a$, was strong enough to come within the name of the Stronger Light, that between $x\ x$, and $c\ c$, was still stronger, and I could distinctly see the old Stronger Light keeping along its old straight course $x\ x$; this new addition being evidently an extraneous thing. Being at sea, I had a clear open horizon; and the night, remarkably clear, was very favorable for observations. Of the Stronger Light, decidedly the brightest part was below the zigzag.

At 8^h 45^m there was still a remnant of the Stronger Light; but the bounds of both this and the Diffuse were now too indistinct to be made out reliably.


N 212

No. 213.

SEPTEMBER 13th, 1854: Evening.

Lat. at 8*h*., 23° 4′ N.: Lon. 116° 47′ E.
Sun set at 6*h*. 3*m*.
Stronger and Diffuse Light at 7*h*. 15*m*. and 7*h*. 45*m*.

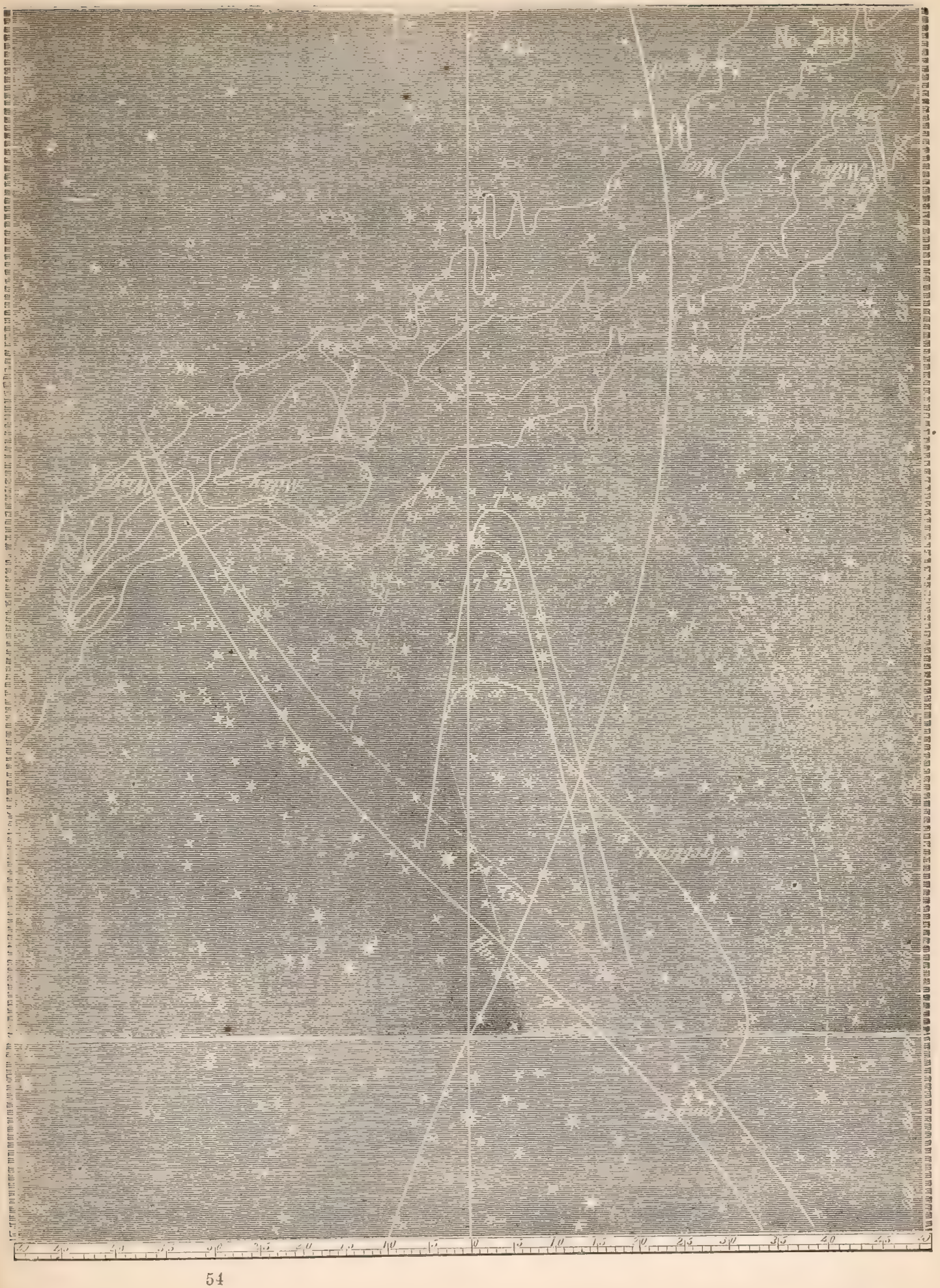
Sky bright and clear. Paid particular attention to the off-shoot *a a*, of the Stronger Light; but its character, as apparent Zodiacal Light, was not so striking as at the same hour last night; there being now a little haziness along the horizon. Still, the sudden termination of this Light on the right hand was very obvious; the horizon, both on right and left, beyond the limits marked, being dark. I paid particular attention, also, to the boundaries of the Diffuse Light, and took them carefully. The Stronger Light was strongest up to the zigzag line at *x*, and was not well marked at its upper end. Its old course down the ecliptic was distinct, notwithstanding the adjunct Light towards *b b*. I neglected to take this last at $7^h\ 45^m$.

I was tolerably certain that there were pulsations. The dimming was very rapid; but the brightening up again was so very slow and gradual, that it was nearly, if not quite, impossible to note it reliably. I made the following notes:

h. *m*.	*h*. *m*.
At 7 28, bright.	At 7 35, almost gone.
7 29½, dimmed.	* * *
* * *	7 43½, dim.
7 34, bright.	7 47, bright again.
7 34½, sensibly dimmer.	

The asterisks designate periods during which I was not certain enough to feel authorized to mark changes, though they seemed to be going on.

At $8^h\ 10^m$ the Light was still very distinct, but its outlines could not be got reliably. At 9^h, nothing more could be fully made out, though the Diffuse Light seemed to be still evident.

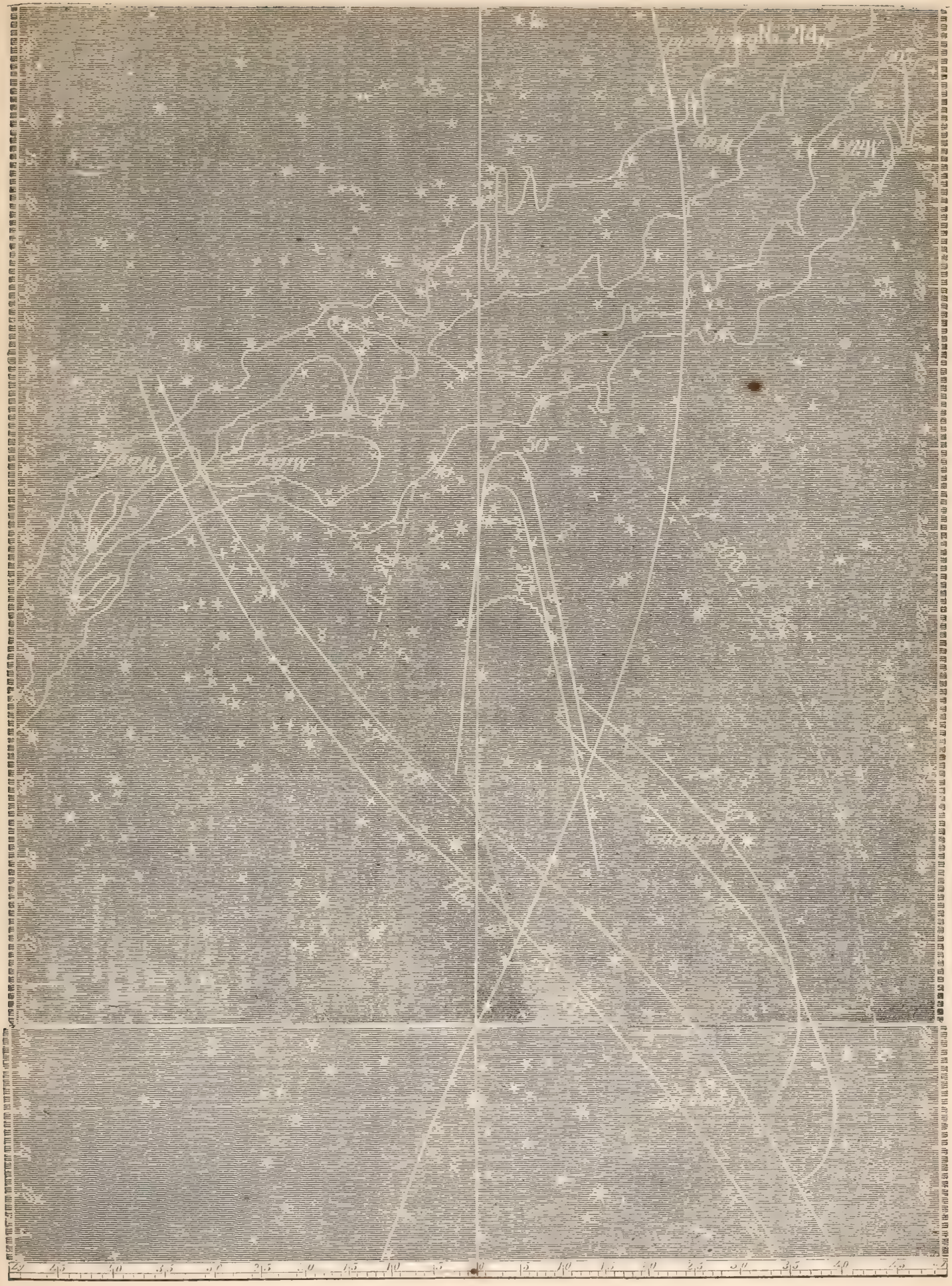


No. 214.

SEPTEMBER 14th, 1854: Evening.

Lat. at $7h.$ $30m.$, 24° 5′ N. : Lon. 118° 41′ E.
Sun set at $6h.$ $2m.$
ronger and Diffuse Light at $7h.$ $20m.$ and $7h.$ $50m.$

I am inclined to think that the adjunct Light to *b b* and *a a* is only a reflection from the atmosphere; yet there are some things about it antagonistic to this idea. I watched this evening, so as to observe it carefully from the first. After sunset, there was a reddish horizon light (evidently twilight), yet extending only from *c* to *d* (see chart on the horizon of 7^h 20^m), and terminating somewhat abruptly at those points. As the evening grew on, this redness gave place to a whitish light, keeping the same extent on the horizon, but increasing in breadth, till at 7^h 20^m it had the boundaries *b b*, as in the chart, being double the width of the first reddish light. But this increase in width may have been owing to the increasing darkness of the sky, making positive light more obvious. The Zodiacal Light, strictly so, was distinct at 7^h 10^m, but did not give boundaries till 7^h 20^m. Looked for pulsations, but could not see any.

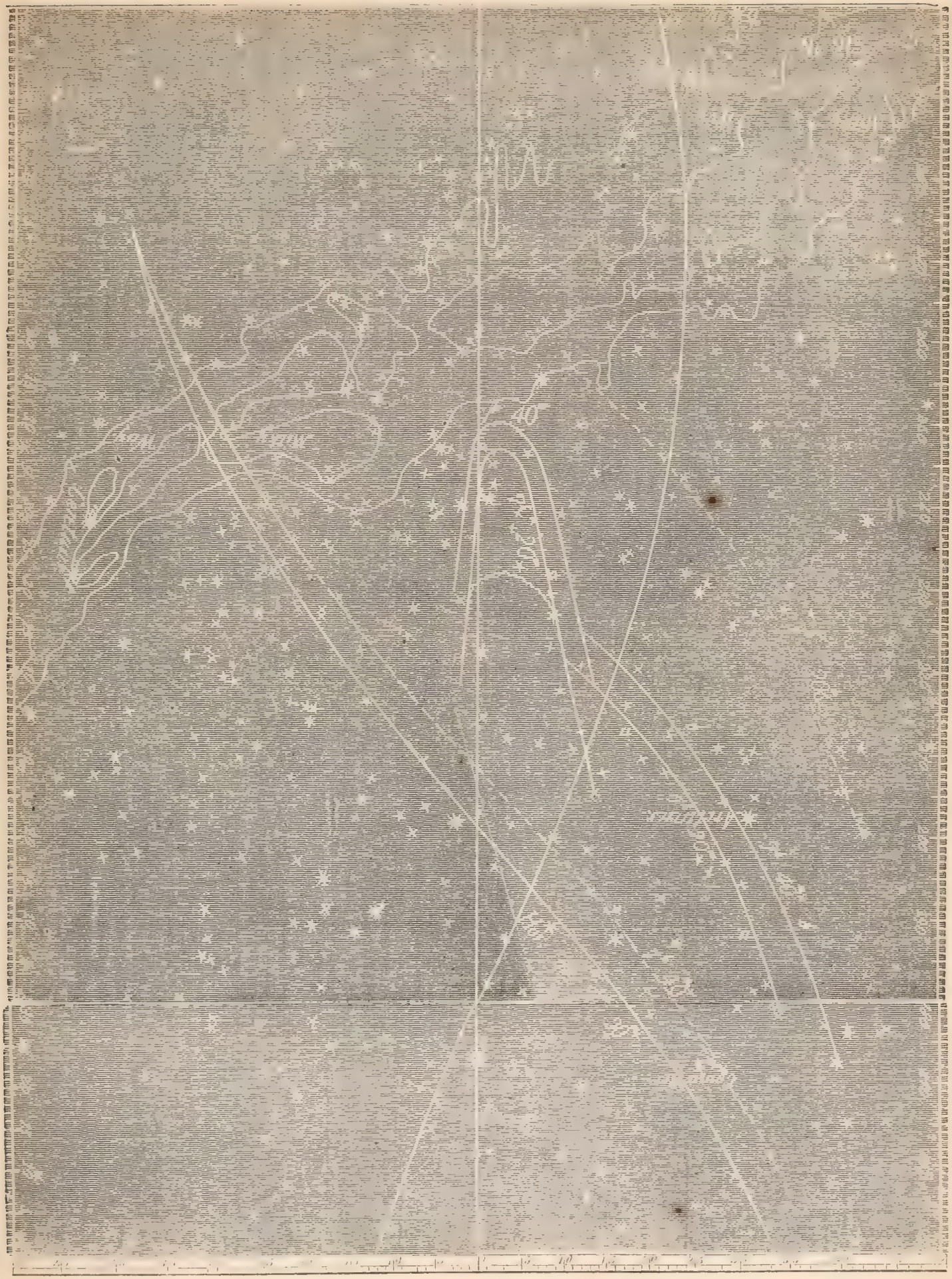


No. 215.

SEPTEMBER 16th, 1854: Evening.

Lat. at 7*h*. 30*m*., 27° 31′ N.: Lon. 124° 23′ E.
Sun set at 6 o'clock.
Stronger and Diffuse Light at 7*h*. 20*m*. and 7*h*. 40*m*.

Last evening cloudy. This evening, clouds interfered till $7^h\ 20^m$, when I had a good observation. The Stronger Light was brightest up as far as the zigzag; above that, it was dim for it. About α Libræ the light was ($7^h\ 25^m$) as strong as in the Milky Way at η Scorpionis; at the same time the strongest light in the adjunct portion below $\alpha\ \alpha$ was equal to that of the Milky Way between 36 and 26 Scorpionis. At $7^h\ 40^m$ the Stronger Light was quite dim at its upper end, but bright at its lower. At $7^h\ 45^m$, difficult to make out its boundaries. At $8^h\ 15^m$ the Zodiacal Light was very decided within the Diffuse boundaries, as given on the chart; but no Stronger Light could be made out. At $9^h\ 20^m$ the upper end of the Diffuse Light was still left apparently, but was not reliable.

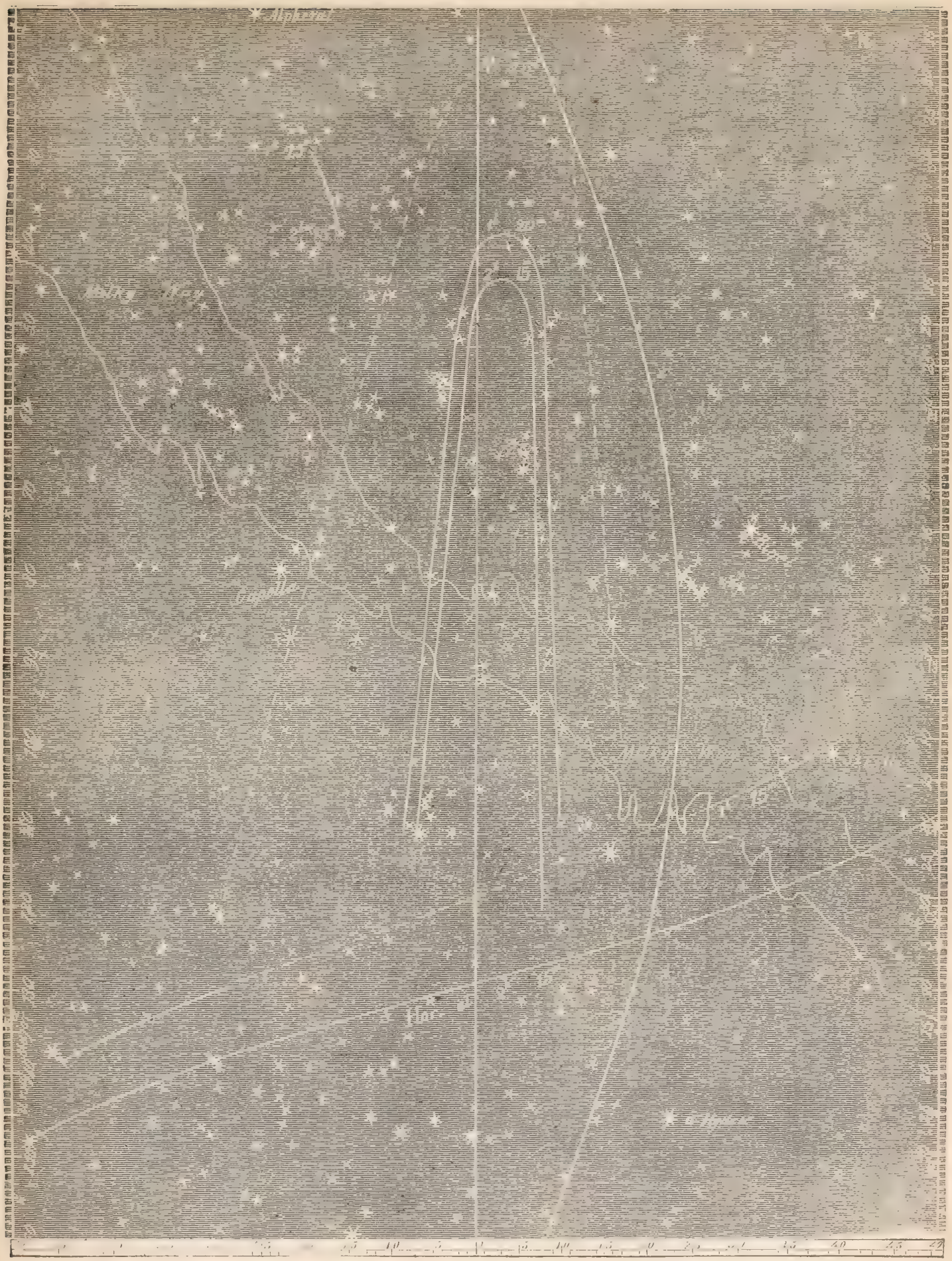


No. 216.

SEPTEMBER 19th, 1854: MORNING.

Lat. at 2*h*., 29° 50′ N.: Lon. 131° 31′.
Sun rose at 5*h*. 51*m*.
Stronger Light at 1*h*. 20*m*. and 2*h*. 15*m*.: Diffuse 1*h*. 25*m*.
Sun's Lon. 176° 11′.

(17th was Sunday.) Cloudy last evening. Moon in the morning until this a. m. Was on deck at 1 o'clock, and found the Zodiacal Light very distinct at the lower part; dim at the upper end. Sky very brilliant, but was troubled by passing cirri. Moon rose not long after the second observation.



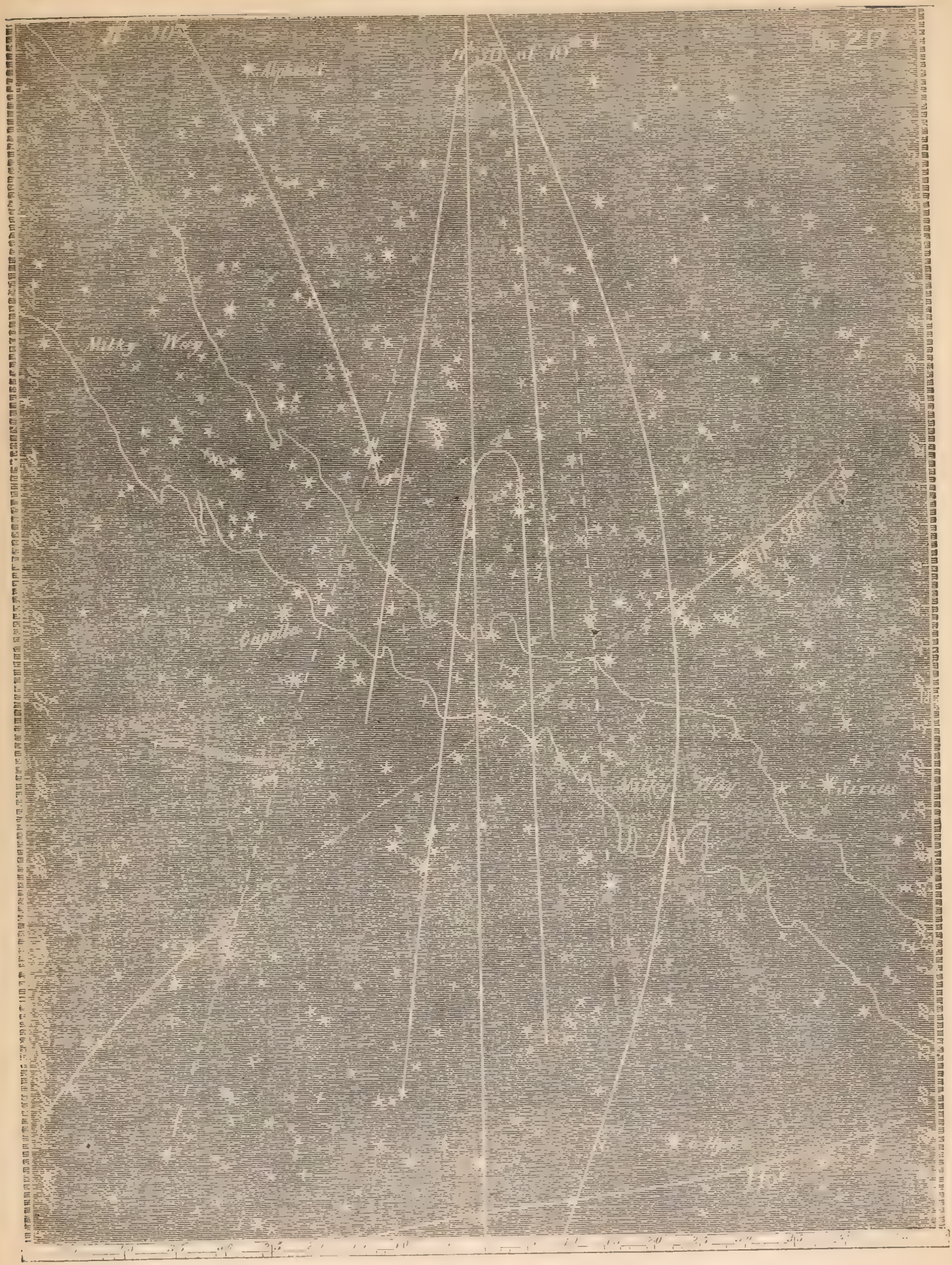
No. 217.

SEPTEMBER 20th. 1854: MORNING.

Lat. at 4^h, 32° 6′ N.: Lon. 135° 8′ E.
Sun rose at 5^h. $51\frac{1}{2}^m$.
Stronger Light at 11^h. 30^m. of 19th, and 4^h. of 20th: Diffuse 4^h.
Sun's Lon. 177° 10′.

Clouds in the west last evening. Was on deck for an *eastern* observation at 11 o'clock; and the Zodiacal Light there, though dim, was quite decided at that time. Shifting clouds, however, prevented my getting outlines until 11^h 30^m. Clouds prevented all further observations until 4^h a. m., when I had a good one, except that the clouds shut out the view near the horizon. The sky above was very bright.

The moon, after rising, was hid by the clouds on the horizon, and I had observations later than could otherwise have been procured.


Milky Way
Milky Way

No. 218.

SEPTEMBER 20th, 1854: Evening.

Lat. at 8*h*., 33° 27′ N.: Lon. 137° 40′ E.
Sun set at 5*h*. 56½*m*.
Stronger Light at 7*h*. 15*m*. and 7*h*. 45*m*.: Diffuse 7*h*. 20*m*., 7*h*. 45*m*., and 8*h*. 30*m*.
Zenith point at 7*h*. 20*m*, Lat. 54° 50′ N.: Lon. 299°. At 8*h*. 30*m*., Lat. 50° 20′ N.: Lon. 323°.

Sky good for observations, except a few thin clouds along the horizon, just over the sun. Got boundaries at 7^h 15^m, which I believe may be relied on; but the Stronger Light, within the old boundaries, was dim for it. At 7^h 45^m this Light, within the old bounds, stronger than before, and well defined; while the light below *a a* has faded, except above *b b*: but whether thin clouds may be intervening, and so may produce this latter result or not, I cannot tell.

Last evening, though I could get no full boundaries, I still was able to catch glimpses of the Light here and there; and, towards 8^h, I thought that the Diffuse Light could be seen across the Milky Way. Mr. G—— was sitting with me, and, on my drawing his attention to it, he saw it also. This evening I gave particular attention to it, and the result is in the chart. The evening Diffuse Light is now very strong, and strengthens as the night advances, to a certain period; but still this boundary across the Milky Way may have some doubts attending it, on account of the brightness of Jupiter, which planet is now within these bounds. At 8^h 30^m all was gone except the Diffuse Light, which was still quite distinct.

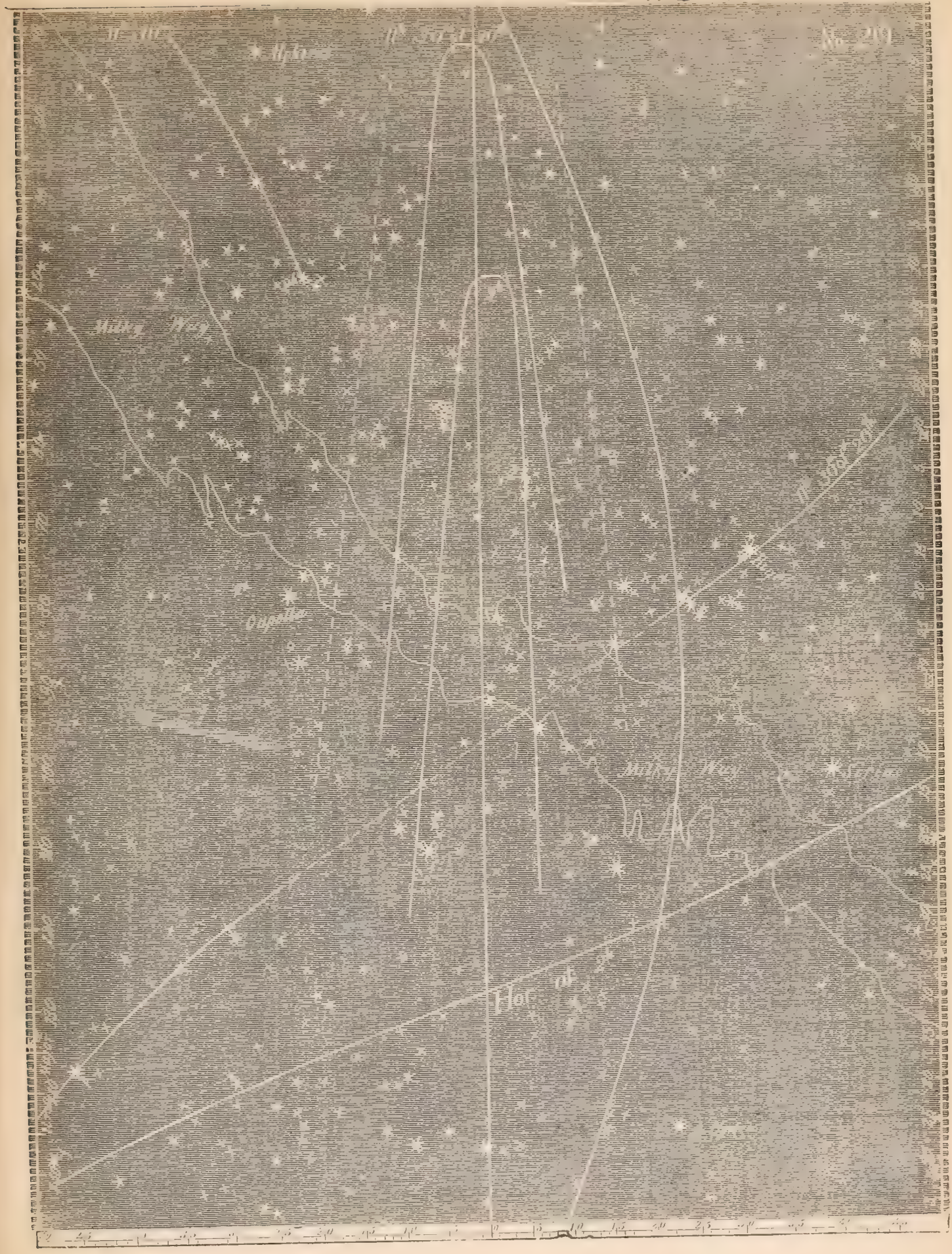
No. 219.

SEPTEMBER 21st, 1854: MORNING.

Lat. at 2*h*., 33° 54′ N.: Lon. 138° 1′ E.
Sun rose at 5*h*. 51*m*.
Stronger Light at { 11*h*. 30*m*. of 20th. / 2 0 of 21st. } Di
Sun's Lon. 178° 9′.

Looked out eastward at half-past 10 last evening, but could see no Zodiacal Light; was on deck again at 11^h 30^m, and then found it quite distinct, its boundaries as in the chart; it was dim, but still very decided. Had another observation at 2 o'clock. Sky very bright and favorable. The Stronger Light was stronger from the horizon up to the Milky Way; but above that, also, it could easily be made out. I intended to have another observation at 4^h, but clouds prevented.

The morning Zodiacal Light is now very bright and striking.


Hydra
Milky Way
Orion
Milky Way
Hor

No. 220.

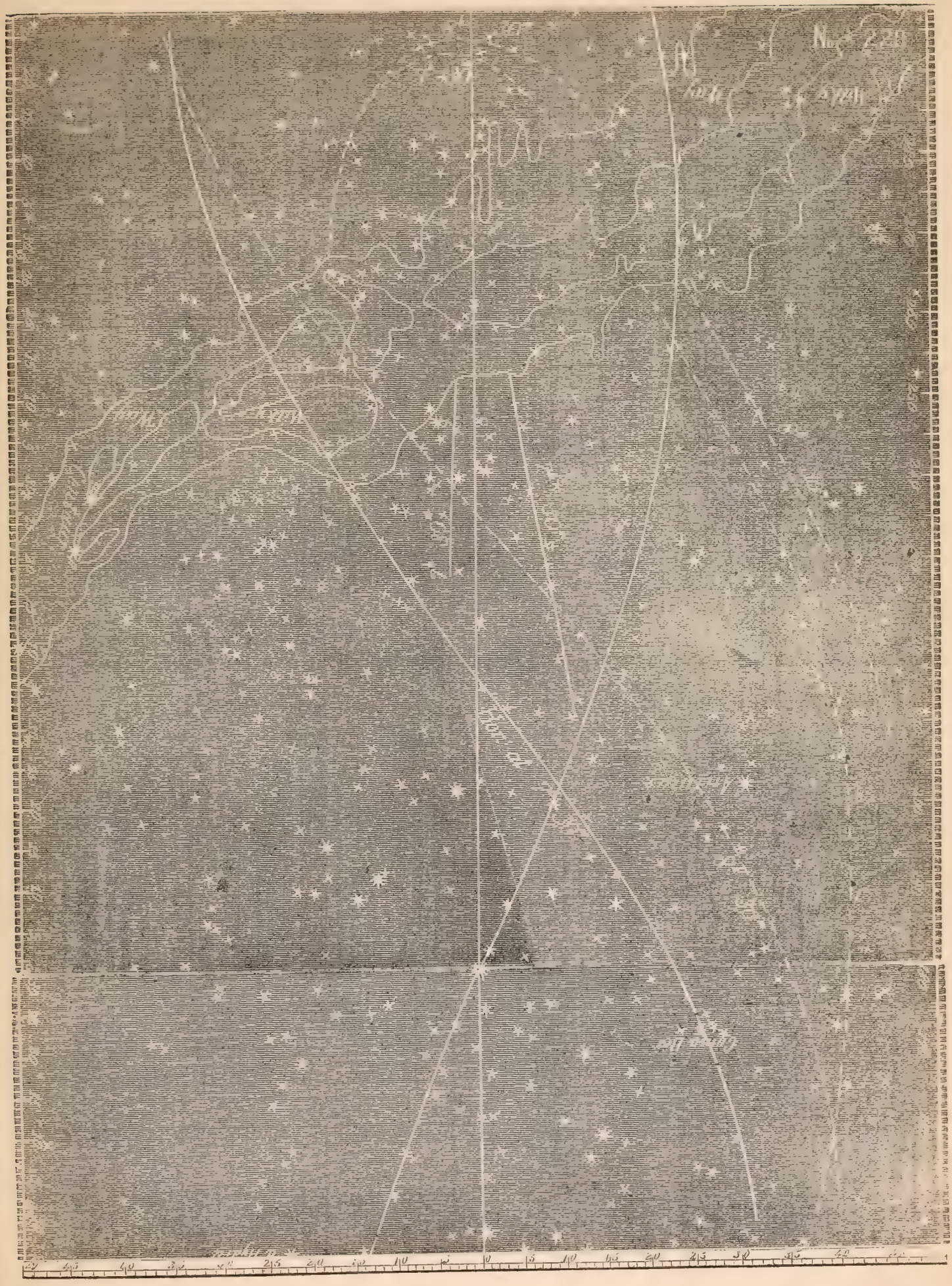
SEPTEMBER 23d, 1854: EVENING.

Lat. 34° 40′ N.: Lon. 138° 58′ E.

Sun set at 5*h*. 52½*m*.

Stronger Light at 7*h*. 30*m*: Diffuse { 7*h*. 30*m*. / 8 30

Clouds since last observation: to-day the equinoctial storm ceased, and was succeeded by a brilliant sky; but some cirri prevented my getting an observation till $7^h\ 30^m$. The old boundaries of the Stronger Light are now badly marked. At $8^h\ 30^m$ only the Diffuse Light could be seen; but this was quite distinct.



No. 221.

SEPTEMBER 27th, 1854: Morning.

Lat. 34° 40′ N.: Lon. 138° 58′ E.

Sun rose at 5*h*. 56*m*.

Stronger Light at { 11*h*. 30*m*. of 26th. / 2 10 of 27th. / 4 0 } Diffuse { 2*h*. 10*m*. / 4 0

Sun's Lon. 184° 2′.

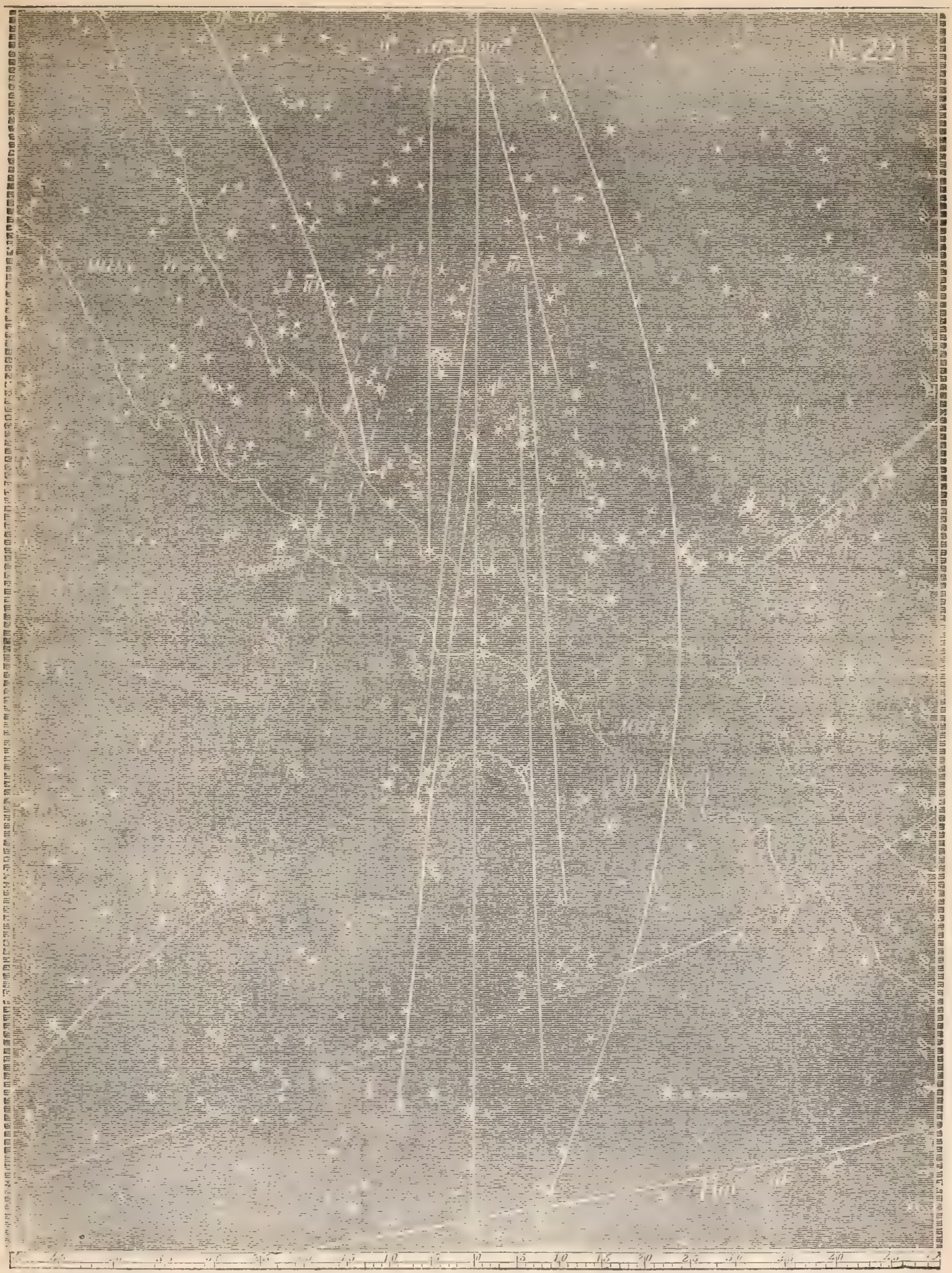
Clouds since last date, except Sunday evening. This morning perfectly clear, and sky very brilliant. Had an eastern observation half an hour before midnight: the Zodiacal Light fully distinguishable: though dim, still quite decided at that hour. At 4^h the Stronger Light was much the brightest from the horizon up to the zigzag: the upper *terminations* of Stronger and Diffuse Light could not be fully made out, and I have marked the places with dots, where by *inference* we may believe them to terminate. After 4^h, I watched carefully to see whether there were pulsations or not; was pretty certain sometimes that there were; at others, was doubtful. Took record of some things that appeared to be changes in *intensity* of light, but it is all so uncertain, that I am scarcely willing to offer the record.

Thus: 4^h 22^m, very dim;

* * bright;

4^h 25^m, dim;

4^h 27$\frac{2}{3}^m$, bright.


N. 221

No. 222.

SEPTEMBER 28th, 1854: Morning.

Lat. 34° 40′ N.: Lon. 138° 58′ E.

Sun rose 5*h*. 57*m*.

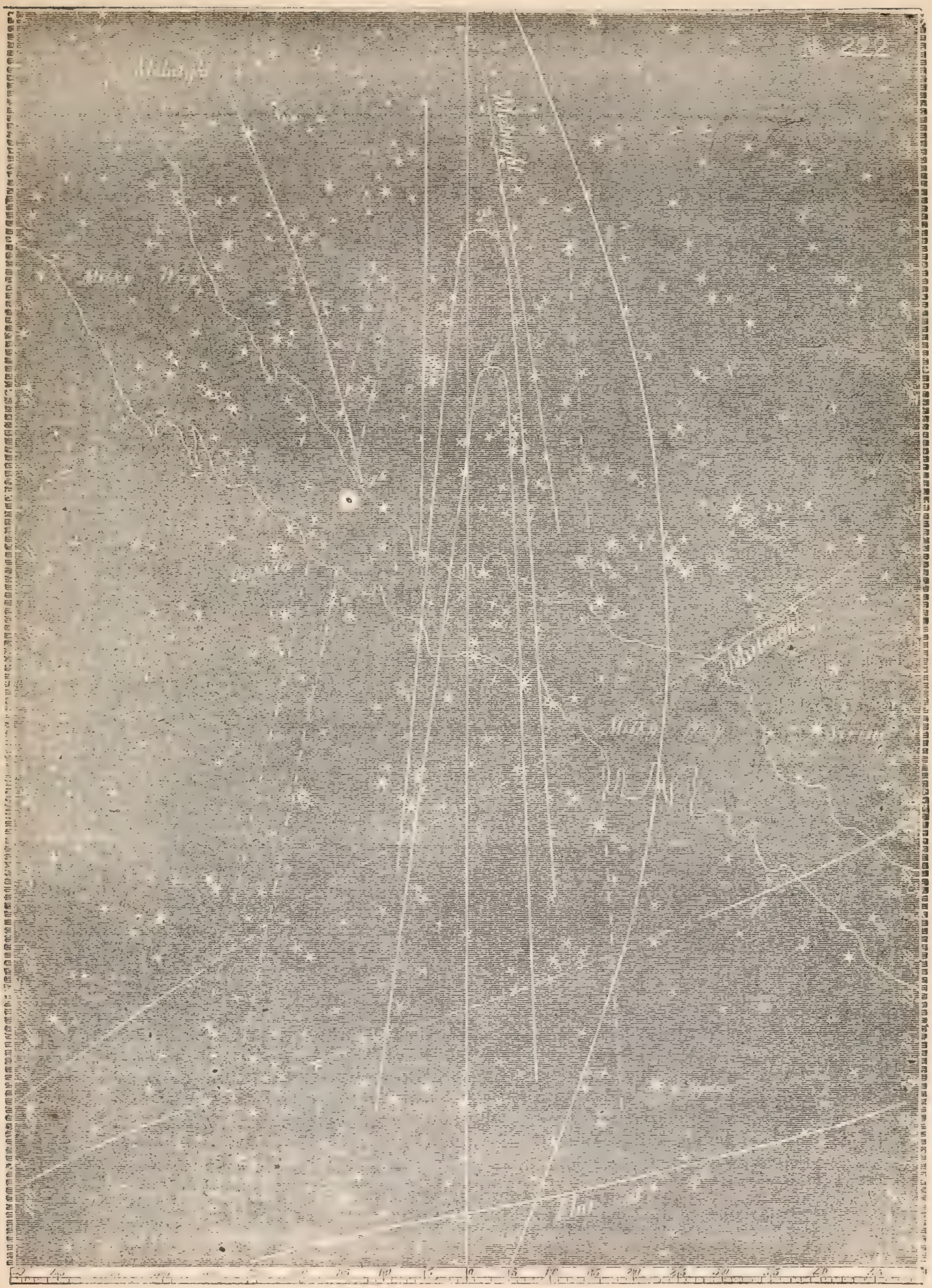
Stronger Light at { Midnight, / 2*h*. 0*m*. / 4 0 } Diffuse 2*h*. 0*m*. and 4*h*. 0*m*.

Sun's Lon. 185° 1′.

A clear, brilliant night. Had an observation at midnight, and gave particular attention to it with reference to the change in the direction of boundaries between 11 and 12 and at 4 o'clock. The result is in the chart. The Light, at midnight, was dim, but very distinct. Observed also particularly with regard to the upper end of both Diffuse and Stronger Lights at the different hours. At 2^h, could make out the termination of the Stronger Light; the Stronger Light at 4^h was far brightest below the zigzag.* The sky was remarkably brilliant.

At 4^h the fowls on board began to crow, deceived, probably, by the brilliancy of the Zodiacal Light, though it was yet three-quarters of an hour short of dawn.

* By inadvertence, this was neglected in this engraved chart. The upper end of the zigzag was at lon. 110°.

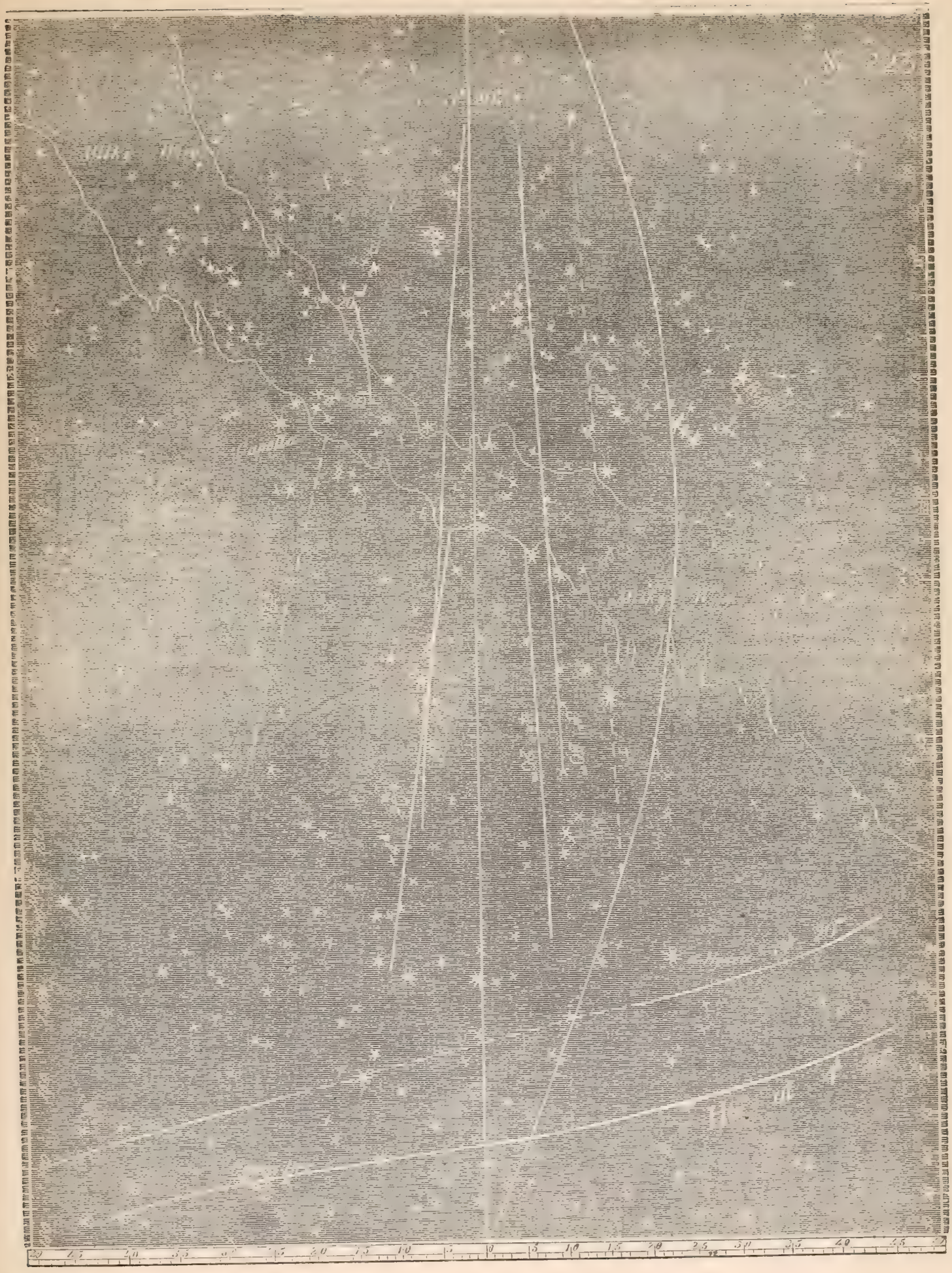


No. 223.

SEPTEMBER 30th, 1854: MORNING.

Lat. 34° 40′ N.: Lon. 138° 58′ E.
Sun rose 5*h*. 57*m*.
Stronger and Diffuse Light at 3*h*. 20*m*. and 4*h*. 20*m*.
Sun's Lon. 186° 59′.

Clouds yesterday morning. Clouds also last night, and until $3^h\ 10^m$ this morning, when the sky became clear, and good for observation. But still the Zodiacal Light this morning, from some unobservable cause, was not as bright as I should have expected. Got boundaries as in the chart.



No. 224.

OCTOBER 11th 1854: Evening.

Lat. at 7*h*., 35° 24′ N.: Lon. 165° 16′ E.
Sun set 5*h*. 27*m*.
Stronger Light at 7*h*. 12*m*. and 7*h*. 37*m*.: Diffuse 7*h*. 2°*m*.
Zenith point at 7*h*., Lat. 53° 25′ N.: Lon. 319°.

Clouds ever since last date (September 30th), until this evening, when, soon after sunset, the sky became quite clear and remarkably good for observations; the western horizon being particularly free from haziness down to the water's edge. I was glad of this, as I wished much to have an evening observation at this time under favorable circumstances, and they were now as good as could possibly be. Sky quite clear and brilliant, and the horizon open and clear. The results were interesting.

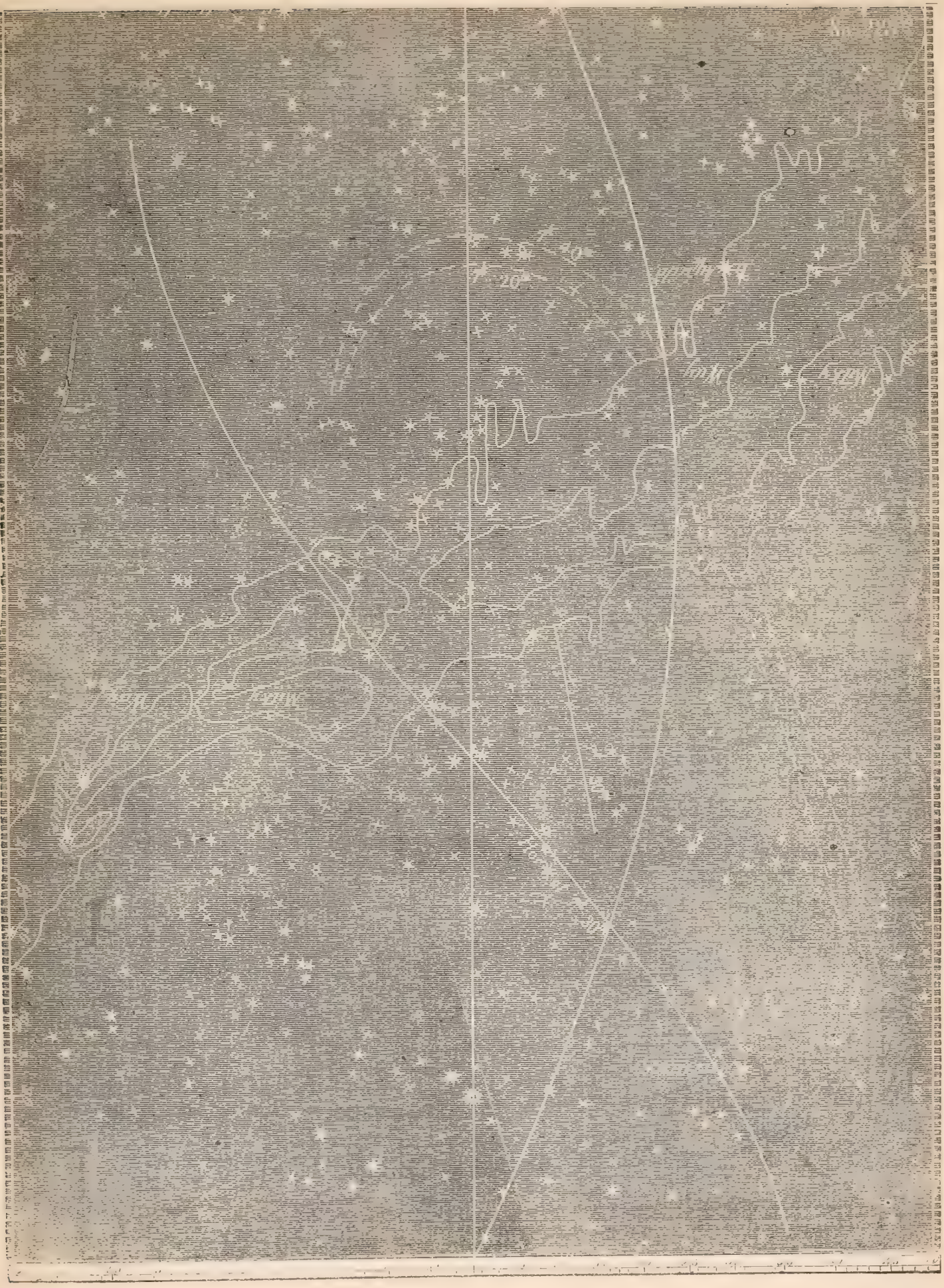
I watched carefully from the beginning. After the sun had set, its light lingered above it for some time, equally on each side. This was evidently atmospherical light. Then the light appeared gradually and imperceptibly to slide to the southward; and, as the darkness increased, at $6^h\ 55^m$, a white light, very decided, showed itself within the dotted boundary *a a*. This light was strong to the horizon, and was different from any thing seen beyond it on the north or south; although, northwardly, a whitish light continued on near the horizon. By $7^h\ 12^m$ the darkness had become complete, and the light had now changed. I could make out the boundaries *b b b b*; I thought them pretty distinct, the horizon being still remarkably clear. At $7^h\ 20^m$, the light bounded by *a a* had widened, and had become the Diffuse Light, with boundaries (*c*) as in the chart. (In making out the extreme end of this, I found Jupiter's light troublesome, but believe I have got the true boundaries, notwithstanding.) At $7^h\ 37^m$, I was confirmed in my belief that I had, at $7^h\ 12^m$, got the boundaries of the Stronger Light, by finding that the upper boundary had now slid up to *d d*, changing its direction in consequence of the change of angle in the horizon. I could see it also extending across the clear interval in the Milky Way. At $7^h\ 42^m$, Diffuse Light on left of Milky Way now quite decided; boundaries as before. At 8 o'clock the Light could be seen, but was too dim to give boundaries.

No. 225.

OCTOBER 12th, 1854: Evening.

Lat. at 7*h*., 35° 33′ N.: Lon. 169° 18′ E.
Sun set at 5*h*. 26*m*.
Stronger Light at 7*h*. 30*m*.: Diffuse 7*h*. 20*m*. and 7*h*. 40*m*.
Zenith point at 7*h*. 30*m*.: Lat. 50° 8′ N.: Lon. 330° 30′.

This evening was not so favorable as the last. There was a permanent stratum of clouds near the horizon, with passing cirri higher up. By watching carefully, I was able, however, between the clouds, to catch boundaries, and to complete them as in the chart. The boundary of the Stronger Light cannot be fully depended on, as it is at best badly marked, and requires more deliberate observation than I was able to give it, in order to be entirely reliable. It is here offered as it seemed to me to be. When Jupiter was obscured by small clouds, the Diffuse, on the left of the Milky Way, was very perceptible.

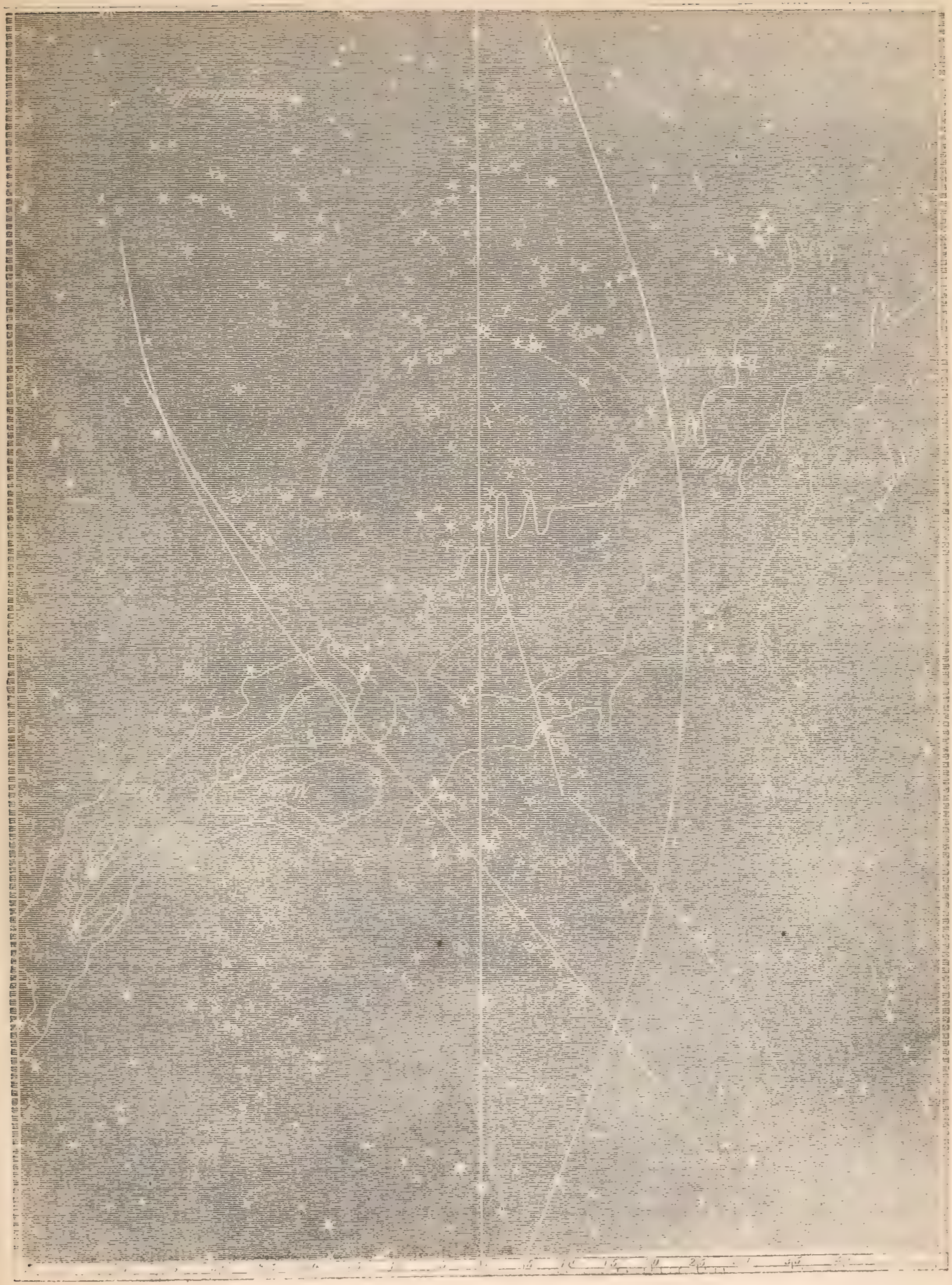


No. 226.

OCTOBER 14th, 1854: Evening.

Lat. at 7*h*. 15*m*., 33° 46′ N.: Lon. 175° 52′ E.
Sun set at 5*h*. 24*m*.
Stronger Light at 7*h*. 15*m*.: Diffuse 7*h*. 15*m*. and 7*h*. 45*m*.
Zenith point at 7*h*. 15*m*.: Lat. 49° 10′ N.: Lon. 327° 30′: At 7*h*. 45*m*.: Lat 46° 30′ N.: Lon. 336°.

Clouds last evening; also this evening until $7^h\ 15^m$, when I had an observation: sky good. There was a brightness, of uncertain character, below the line *b b*. The line given as for Stronger Light, at $7^h\ 15^m$, was so imperfectly marked in the sky, that I hesitated about drawing it. There is evidently a streak of unusual brightness between this line and Antares, stretching in the usual course of the Stronger Light, and crossing the blank space in the Milky Way; but its upper boundary is badly marked, and its lower one is now usually hidden by clouds, or blotted out by haziness on the horizon.



No. 227.

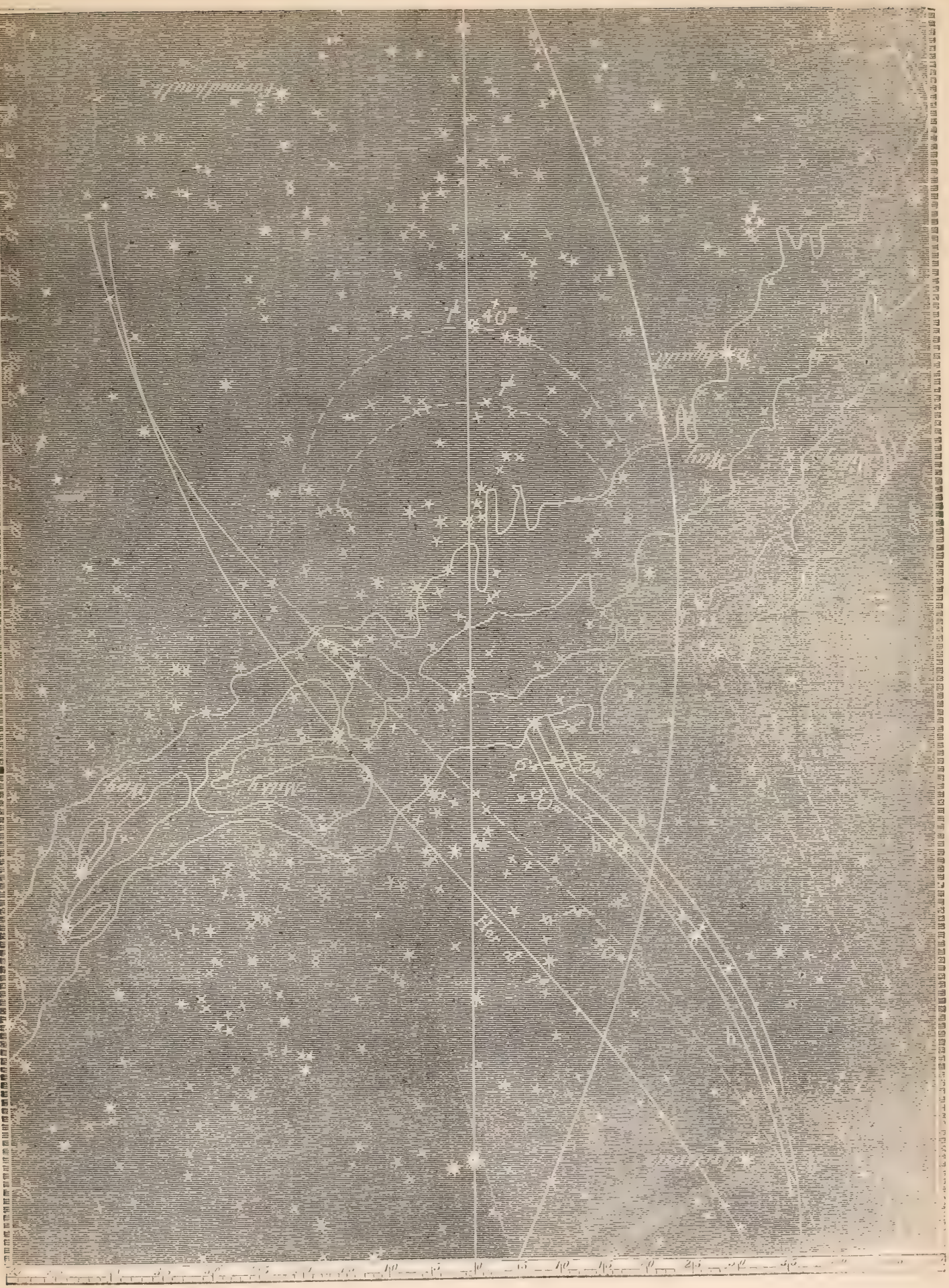
OCTOBER 16th, 1854: Evening.

Lat. at 7*h*., 33° 16′ N.: Lon. 178° 21′ W

Sun set 5*h*. 22½*m*.

Stronger Light at { 6*h*. 50*m*. / 7 0 / 7 40 } Diffuse 7*h*. 0*m*. and 7*h*. 40*m*.

Clouds last evening. The sky this evening very favorable for observations, and I had one at $6^h\ 50^m$. Thought I could still see the upper boundary of the Stronger Light, and that I could discern the lower edge of the same at Antares; but for the latter there was not sufficient space between the Milky Way and the horizon to give me the direction. The whitish light along the horizon still continues; and I have given its boundaries *b b* up to $7^h\ 40^m$, at which time it was merging itself into the Diffuse Light, and its limits were becoming badly defined. Soon after, the whole Zodiacal Light was so dimly marked that I ceased to make observations.



No. 228.

DUPLICATE* OCTOBER 16th, 1854: MORNING.

Lat. at 1*h*., 33° 16′ N.: Lon. 177° 28′ W.
Sun rose at 6*h*. 10*m*.
Stronger and Diffuse Light at 0*h*. 30*m*. and 1*h*. 0*m*.
Sun's Lon. 202° 45′.

Clouds and the moon in the morning, since September 30th. Was on deck at $11^h\ 30^m$, but clouds were in the way. About 15^m after midnight the sky became clear, and was very bright and favorable; clear down to the horizon. The Zodiacal Light could then be perceived, but it was very dim—only a faint tinging of the sky. The boundaries of the Diffuse Light were better marked than those of the Stronger Light. By 1 o'clock the latter were more decided, and were quite reliable. I could get no reliable boundaries above the Milky Way. The moon, now approaching the horizon, began soon after to give additional brightness within the limits marked as those of the Stronger Light. The moon showed itself on the horizon at $1^h\ 8^m$.

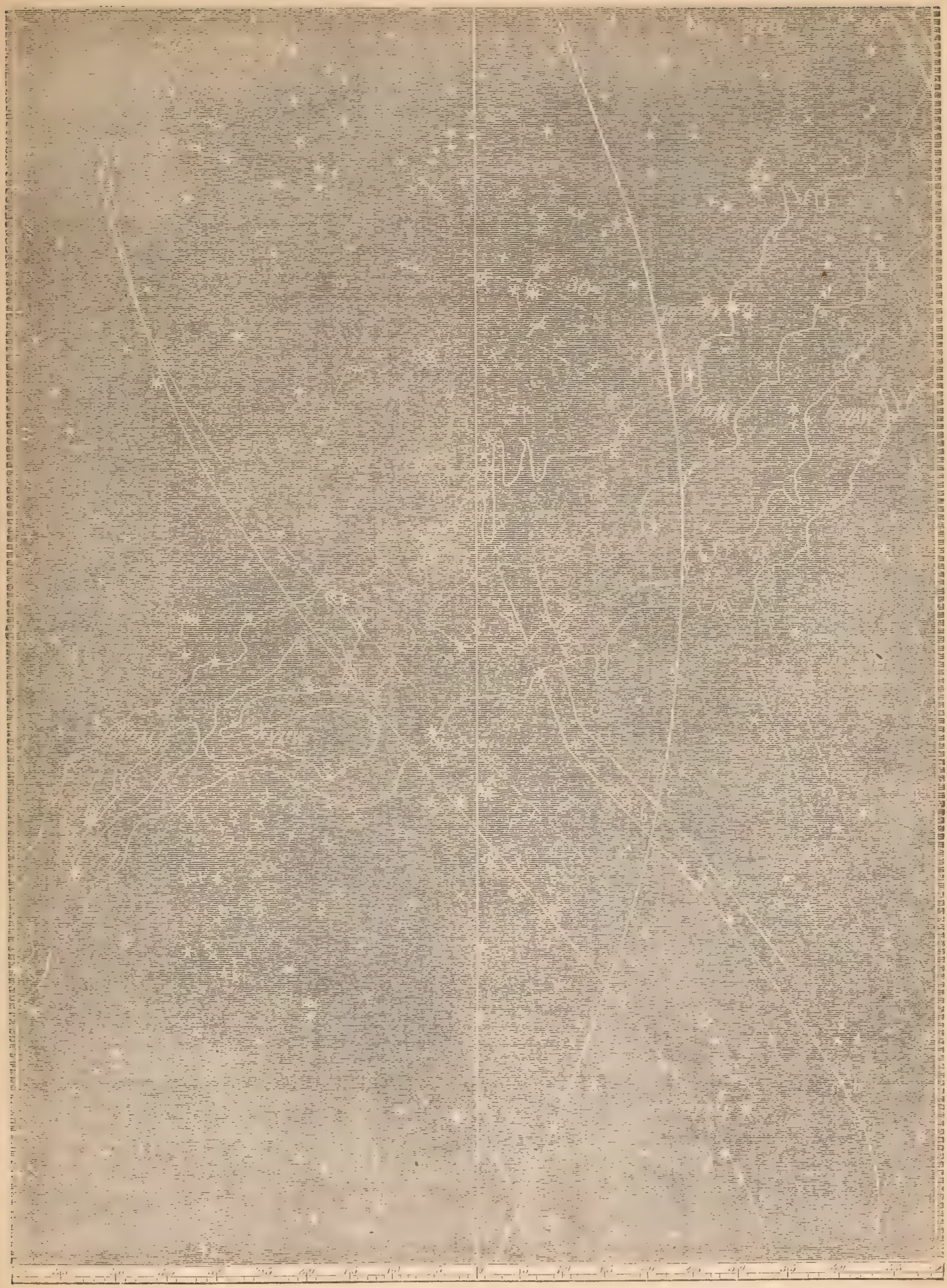
* I have called this "*Duplicate* 16*th*," because, although this is properly Tuesday, 17th, we drop a day, and call it *Monday* 16*th*, as yesterday, in order to have our reckoning on arriving at home, as we shall find it there. It is customary with our ships, when circumnavigating the globe, thus to rectify their time on crossing the 180th degree of longitude from Greenwich, by dropping a day (calling two days one), if going eastward, and by adding a day, if in the opposite direction.

No. 229.

DUPLICATE OCTOBER 16th, 1854: EVENING.

Lat. at 7*h*., 33° 01′ N.: Lon. 174° 49′ W.
Sun set at 5*h*. 21*m*.
Stronger and Diffuse Light at 7*h*. and 7*h*. 30*m*.

Sky perfectly clear, and very brilliant. I noticed that at $7^h\ 10^m$ the adjunct light under *b b* had the same warm tint that the Zodiacal Light has—different from horizon or Milky-Way Light. At $7^h\ 30^m$, the upper line of the Stronger Light had evidently tilted up considerably, as given in the chart; the lower boundary could not be made out at this time; also the boundary *b b* had become less marked than before, this latter now becoming merged in the Diffuse Light. At $8^h\ 30^m$ the boundaries of the Diffuse Light were about the same as at the last observation.

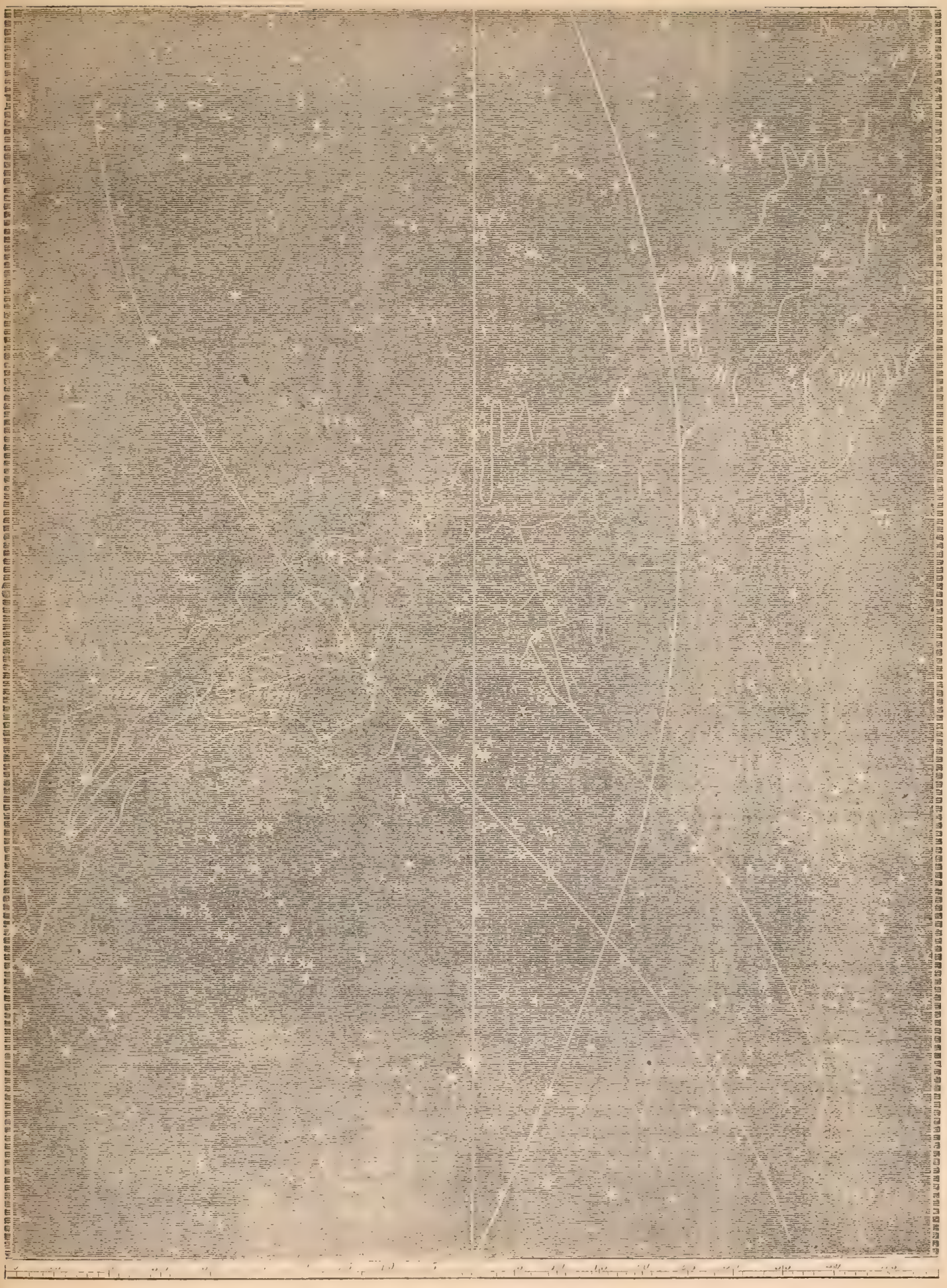


No. 230.

OCTOBER 17th, 1854: EVENING.

Lat. at 7*h*. 31° 52′ N.: Lon. 171° 28′ W.
Sun set at 5*h*. 22*m*.
Stronger Light at 6*h*. 55*m*. and 7*h*. 8*m*.: Diffuse at 7*h*. 10*m*.

Sky very bright. Going on deck at $6^h\ 45^m$, I was struck with a remarkably bright appearance under the line *a a*. It was rather late for twilight, but may have been such light; but it was remarkably bright—as much so as the Strongest Zodiacal Light ever is; and it had the warm tinge of the Zodiacal Light. At $6^h\ 50^m$, it had ascended to the dotted line *b b*, and was extremely bright. Watching it, I thought it had pulsations in intensity. At $6^h\ 55^m$ it had died away considerably in strength, and had ascended to *c c*; $6^h\ 57^m$, at *c c*, and its intensity as on previous nights; $6^h\ 58^m$, at *c c*, and brightness greatly increased; $7^h\ 1^m$, *c c*, and dim again; $7^h\ 3^m$, do., and very dim. After this, constant as at $7^h\ 3^m$. At $7^h\ 30^m$, clouds had overspread the sky, and I could get no further observations. Jupiter makes useless any attempt at observations for the Stronger Light across the further side of the Milky Way.

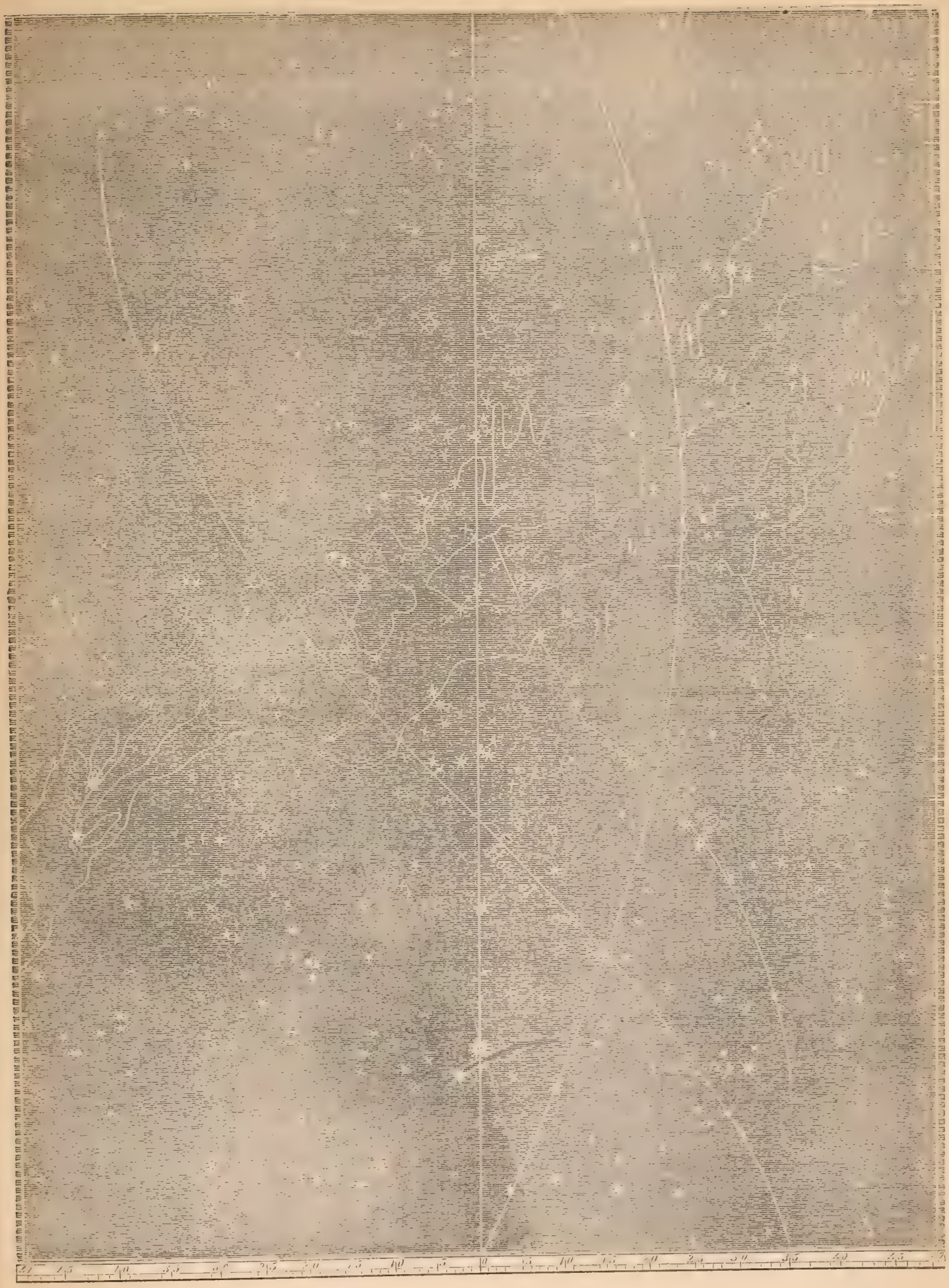


No. 231.

OCTOBER 18th, 1854: Evening.

Lat. at 7*h*., 30° 41′ N.: Lon. 167° 45′ W.
Sun set at 5*h*. 22*m*.
Stronger Light at 6*h*. 50*m*.: Diffuse at 6*h*. 57*m*.

Clouds till $6^h\ 45^m$, when the western sky became clear and very brilliant, except along the horizon. Had an observation about $6^h\ 50^m$. Soon after this, clouds overspread the sky; they continued till morning.

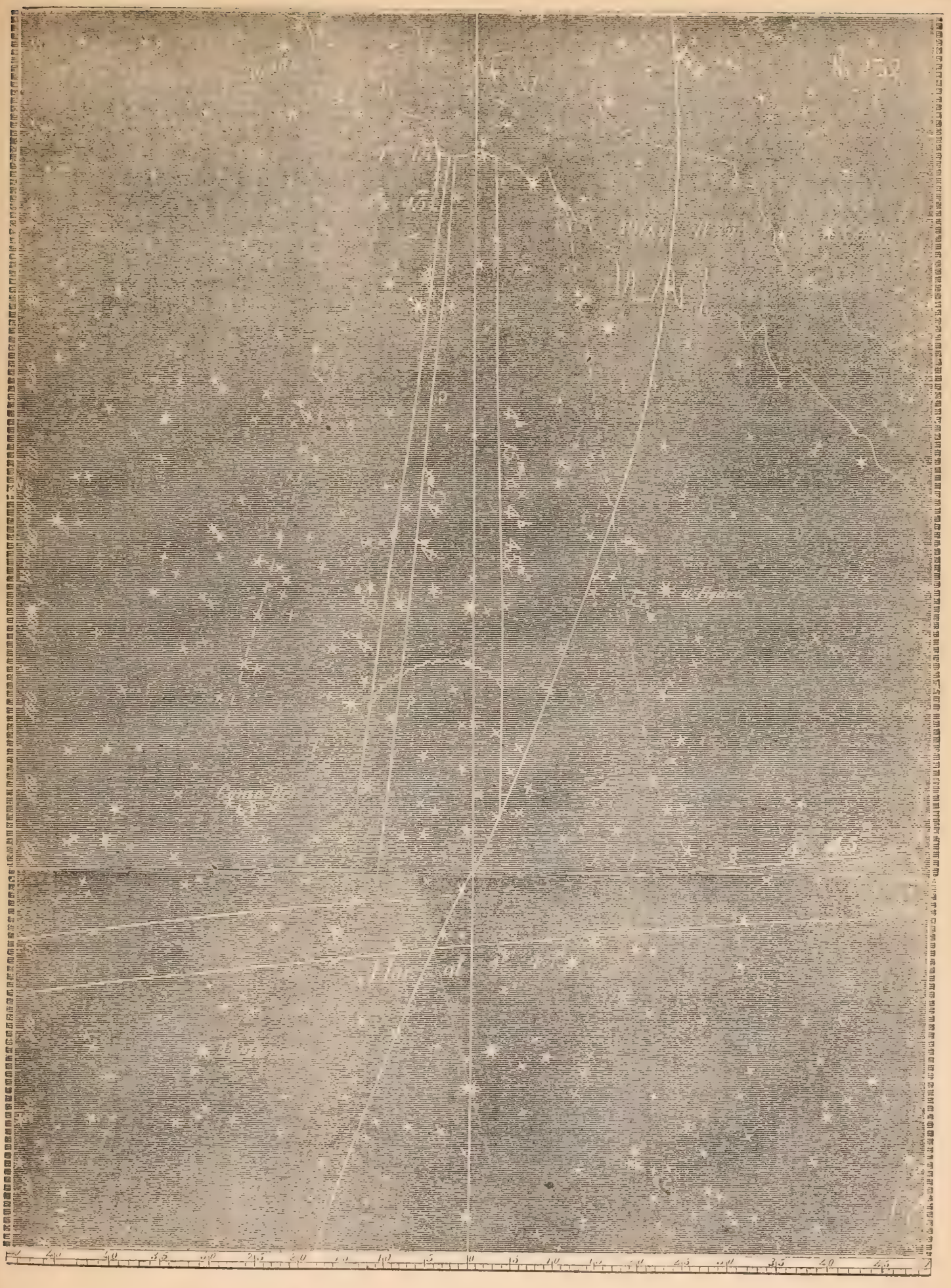


No. 232.

OCTOBER 20th, 1854: Morning.

Lat. at 4*h*., 28° 5′ N.: Lon. 164° 24′ W.
Sun rose at 6*h*. 7*m*.
Stronger Light at 4*h*. 15*m*. and 4*h*. 45*m*.: Diffuse at 4*h*. 15*m*.

Clouds in the morning ever since my last morning observation (16th). Clouds also last evening. They continued until 4^h this a. m., when the sky became beautifully clear and very brilliant. As usual, a far brighter spot towards the horizon, both at $4^h\ 15^m$ and $4^h\ 25^m$, its upper boundary being the zigzag line. Dawn at $4^h\ 50^m$.



No. 233.

OCTOBER 21st, 1854: Morning.

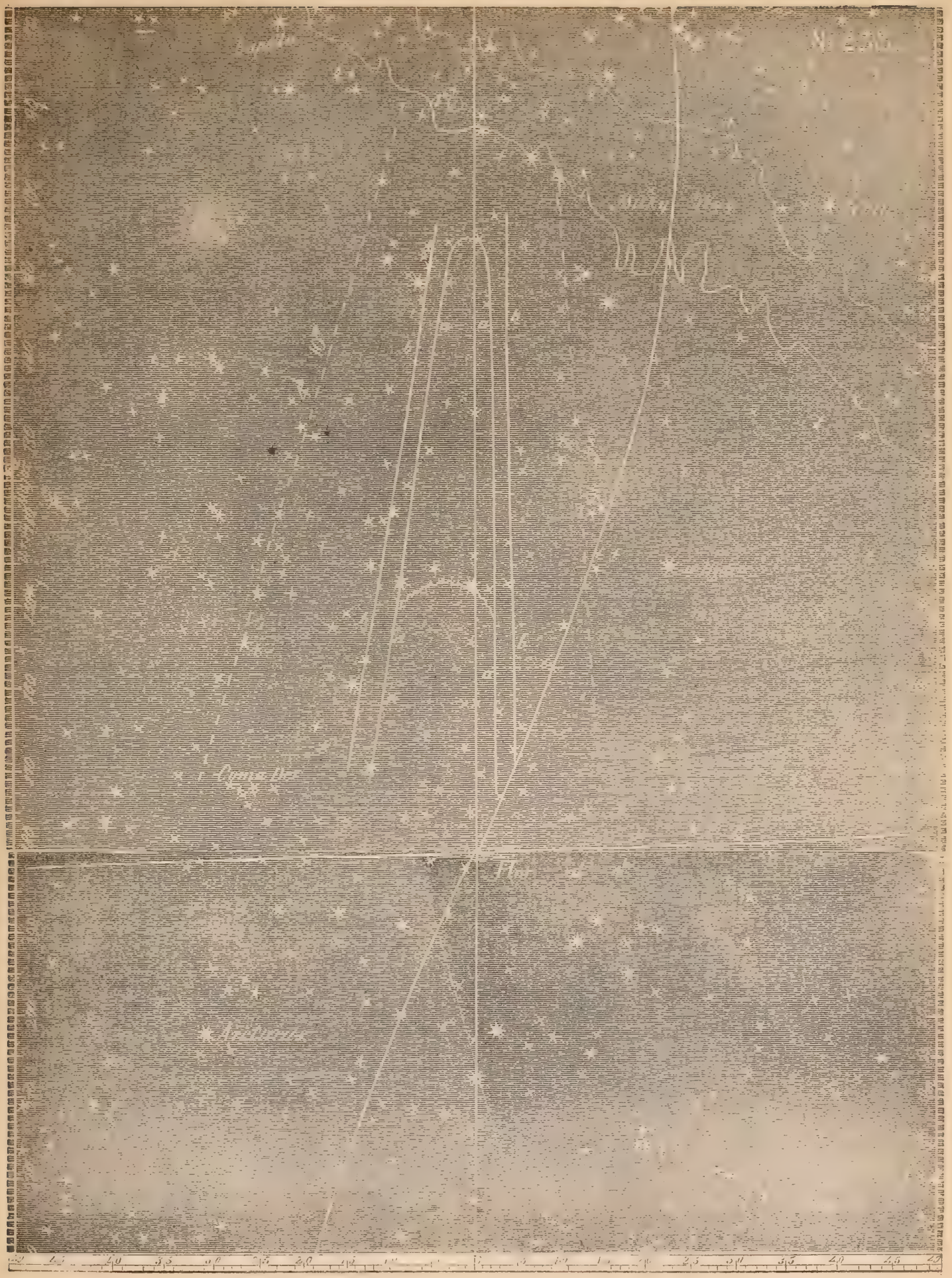
Lat. at 4*h*., 25° 58′ N : Lon. 161° 58′ W.
Sun rose 6*h*. 7*m*.
Stronger Light at 4*h*., &c.: Diffuse at 4*h*. 10*m*.

Clouds last evening, and also this morning, till towards 4*h*, when the sky became clear and was very brilliant. When I went on deck, I was struck with the great brightness of the Zodiacal Light. I then had to change my place from the poop-deck to the port-guard; and though the time occupied by this was not more than two minutes, I thought the brightness had very materially decreased. I watched, from that on, very carefully, to see whether this was only a fancy, (though at that first observation I had not had any thought about pulsations,) or whether there were really pulsations. Sometimes I thought there were, and I made the following records; but I do not offer them as reliable, it being exceedingly difficult to determine whether these apparent changes were true or not; and I had no one near, with whose judgment I could compare my own.

h. *m*.	*h*. *m*.
At 3 52, very dim, and at *a*.	* *
3 58, brightening.	4 14½, very bright, and at *b*.
3 59, much brighter, and at *b*.	4 15, greatly dimmed, and at *a*.
* * * *	* * * *
4 4, very bright, and at *b*.	4 24, extremely bright.

The asterisks mean intervals when, although I thought it possible there were changes, I felt too uncertain to make any record of them.

From the zigzag line down, the Light was much stronger than above, especially as dawn approached. The Stronger Light, all the while, was so bright as to produce quite a decided discoloration of the smooth sea, as the Light was reflected from it.

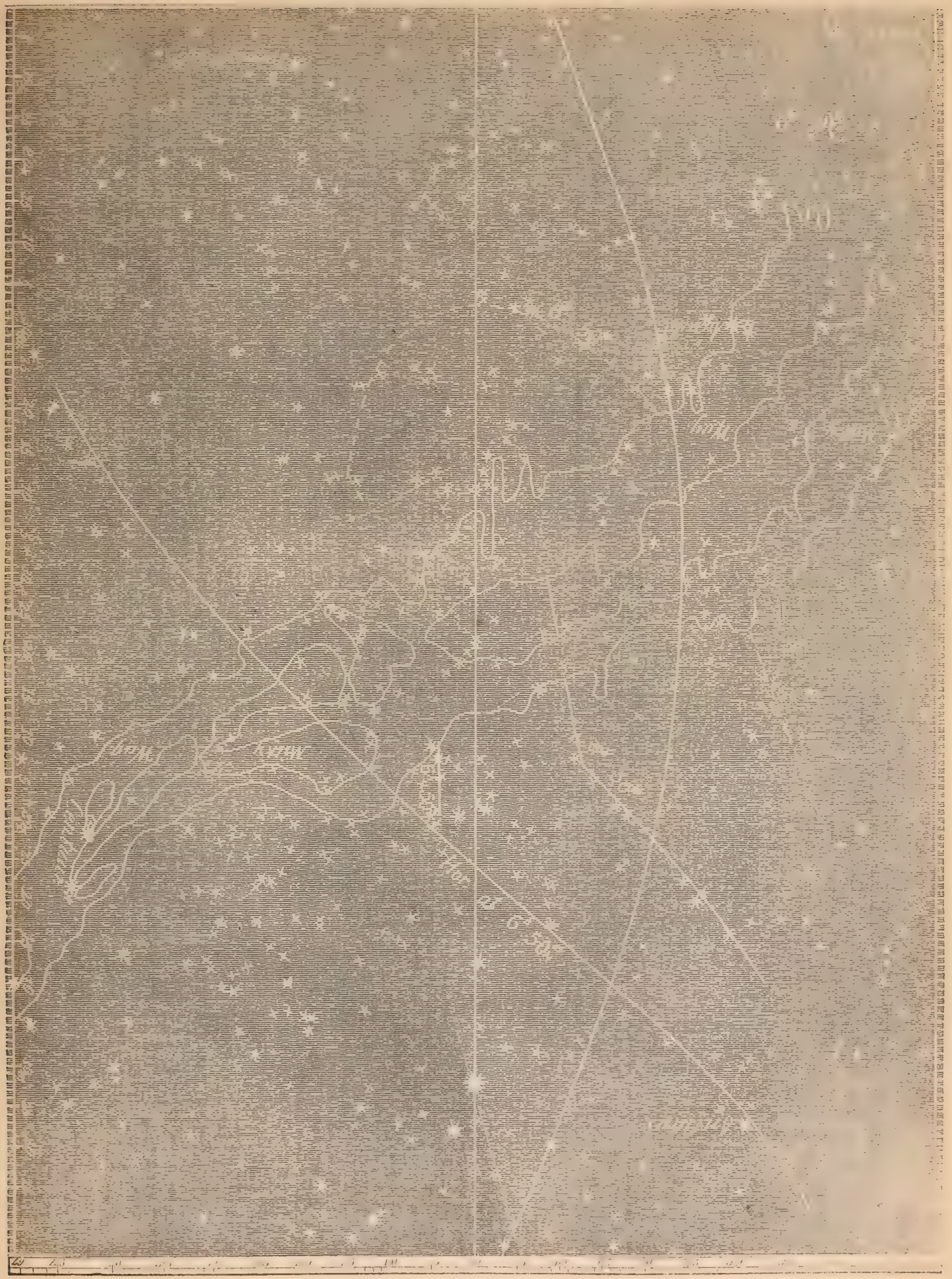


No. 234.

OCTOBER 21st, 1854: Evening.

Lat. at 7*h*., 24° 49′ N.: Lon. 160° 41′ W.
Sun set 5*h*. 24*m*.
Stronger and Diffuse Light at 6*h*. 50*m*.

Sky very bright. The ecliptic has now been lifted up so much by our getting further south, that I was able, this evening, to get the lower boundary of the Stronger Light. This Light seems, also, now to project beyond the Milky Way on the left; but the effulgence of Jupiter prevents my getting its boundaries correctly. Clouds, after 7 o'clock, prevented further observations.



No. 235.

OCTOBER 23d, 1854: Evening.

Lat. 21° 18′ N.: Lon. 157° 55′ W.
Sun set 5*h*. 26½*m*.
Stronger and Diffuse Light at 7 and 8 o'clock.

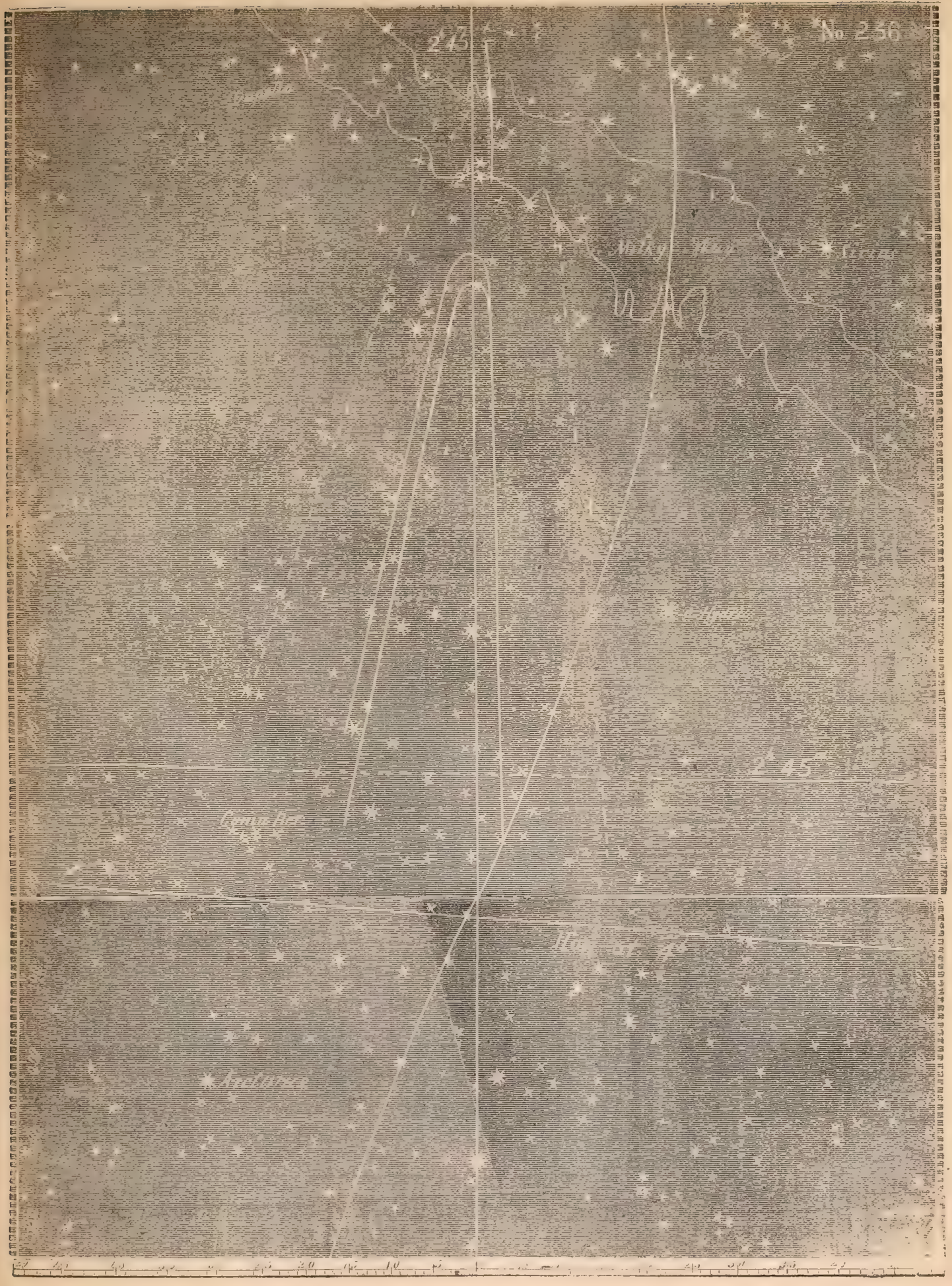
(22d was Sunday.) Clouds this morning. Sky, in the evening, clear and bright. Moon till about 7 o'clock, when I got observations; got boundaries above or on the left of the Milky Way, which I think may be reliable, though Jupiter cast a strong light about that portion of the sky.

No. 236.

OCTOBER 25th, 1854: MORNING.

Lat. 21° 18′ N.: Lon. 157° 55′ W.
Sun rose at 6*h*. 3*m*.
Stronger Light at 2*h*. 45*m*. and 4*h*.: Diffuse at 4 o'clock.

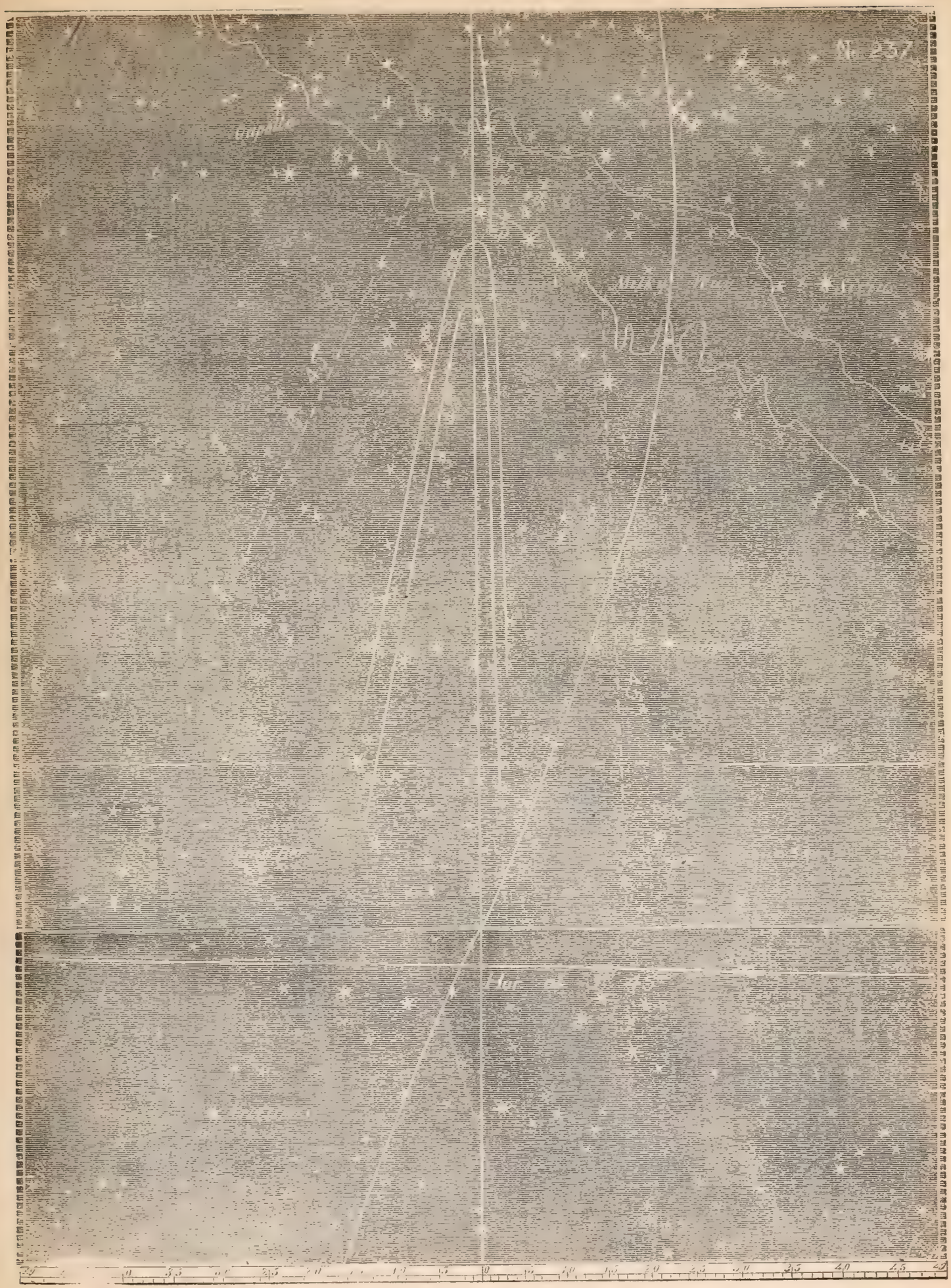
Sky cloudy yesterday morning; moon now in the evening. This a. m. was on deck at $1^h\ 30^m$; but there was no certainty of Zodiacal Light. Out again at $2^h\ 45^m$; sky very brilliant; but there has been a great falling off in the brightness of the early Zodiacal Light; got boundaries at that hour, but the Light was dim. At 4^h, however, it was very bright—remarkably so.


No 256
24
Milky Way
Aquila
Capricornus
Aquarius

No. 237.

OCTOBER 30th, 1854: MORNING.
Lat. 21° 18′ N.: Lon. 157° 55′ W.
Sun rose 6*h*. 6*m*.
Stronger Light at 2*h*. and 3*h*. 45*m*.: Diffuse 3*h*. 45*m*.

Clouds in the morning since last date. Moon in the evening. This morning the sky was very clear and bright, and I had good observations. At 2^h the Light was dim, though quite distinct; at my last observation, it was very bright.

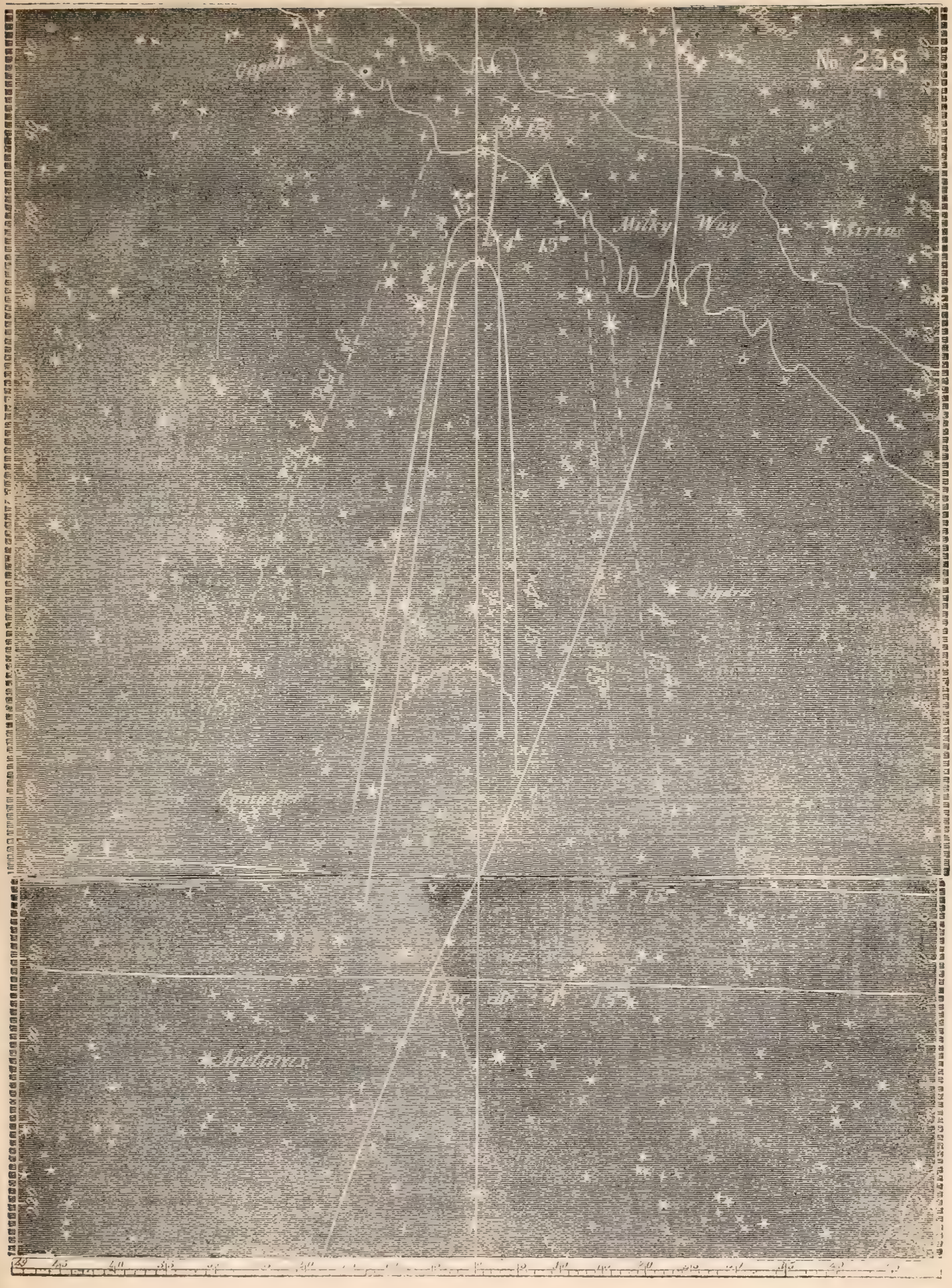

N. 257
Hor. 2

No. 238.

NOVEMBER 1st, 1851: Morning.

Lat. 21° 18′ N.: Lon. 157° 55′ W.
Sun rose at 6*h*. 7*m*.
Stronger and Diffuse Light at 3*h*. 15*m*. and 4*h*. 15*m*.

Clouds yesterday morning. Went out this a. m. at 3^{h}, and found the Zodiacal Light distinct, though dim; the sky not at its brightest. Was able, however, to get boundaries. Out again at 4^{h} 15^{m}, and found that the Light had evidently slid over to the right very considerably. (See the chart.) The bounds of Diffuse Light rather difficult to make out. The Stronger Light much the brightest below the zigzag line.

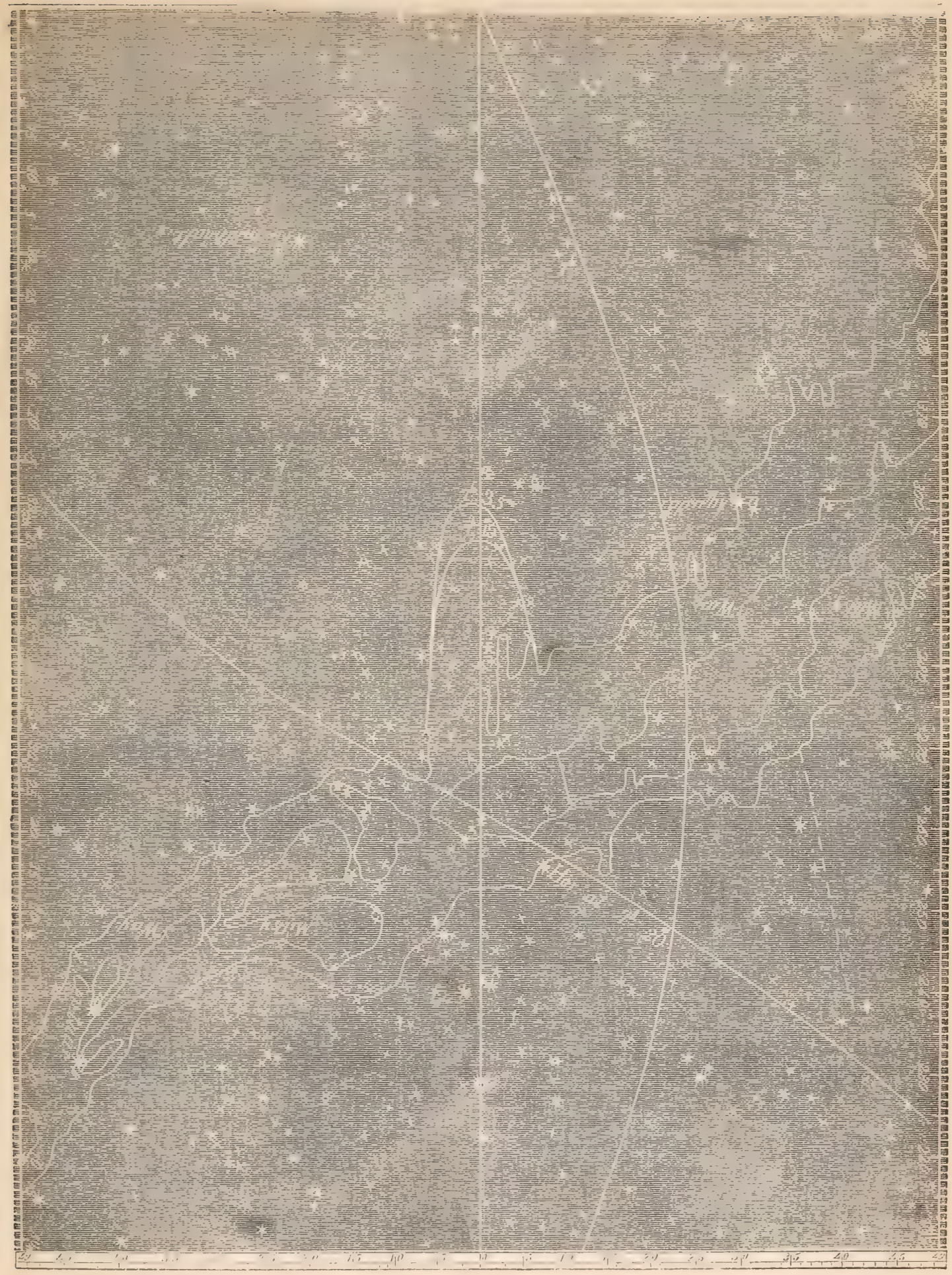

No 238
Capella
Milky Way
Sirius
Hydra
Procyon
Aldebaran

No. 239.

NOVEMBER 11th, 1854: Evening.

Lat. at 7*h*. 20*m*., 23° 52′ N.: Lon. 152° 34′ W.
Sun set at 5*h*. 12*m*.
Stronger Light at 7*h*. 15*m*. and 7*h*. 35*m*.: Diffuse at 7 o'clock.

Clouds or the moon since my last entry (November 1st). Had an observation this evening at $7^h\ 15^m$, but it was unsatisfactory; rendered so by flying clouds, and by the presence of Jupiter at the upper end of the Zodiacal Light. This Light, however, was strong enough, at its lower end, to be distinctly seen crossing the Milky Way. At $7^h\ 35^m$ the observation was more satisfactory, the clouds having disappeared, and the sky being very clear and bright. I think the outlines of the Stronger Light, at this hour, may be considered reliable; but I cannot speak positively about those for the Diffuse Light; this latter being imperfectly marked in the sky.

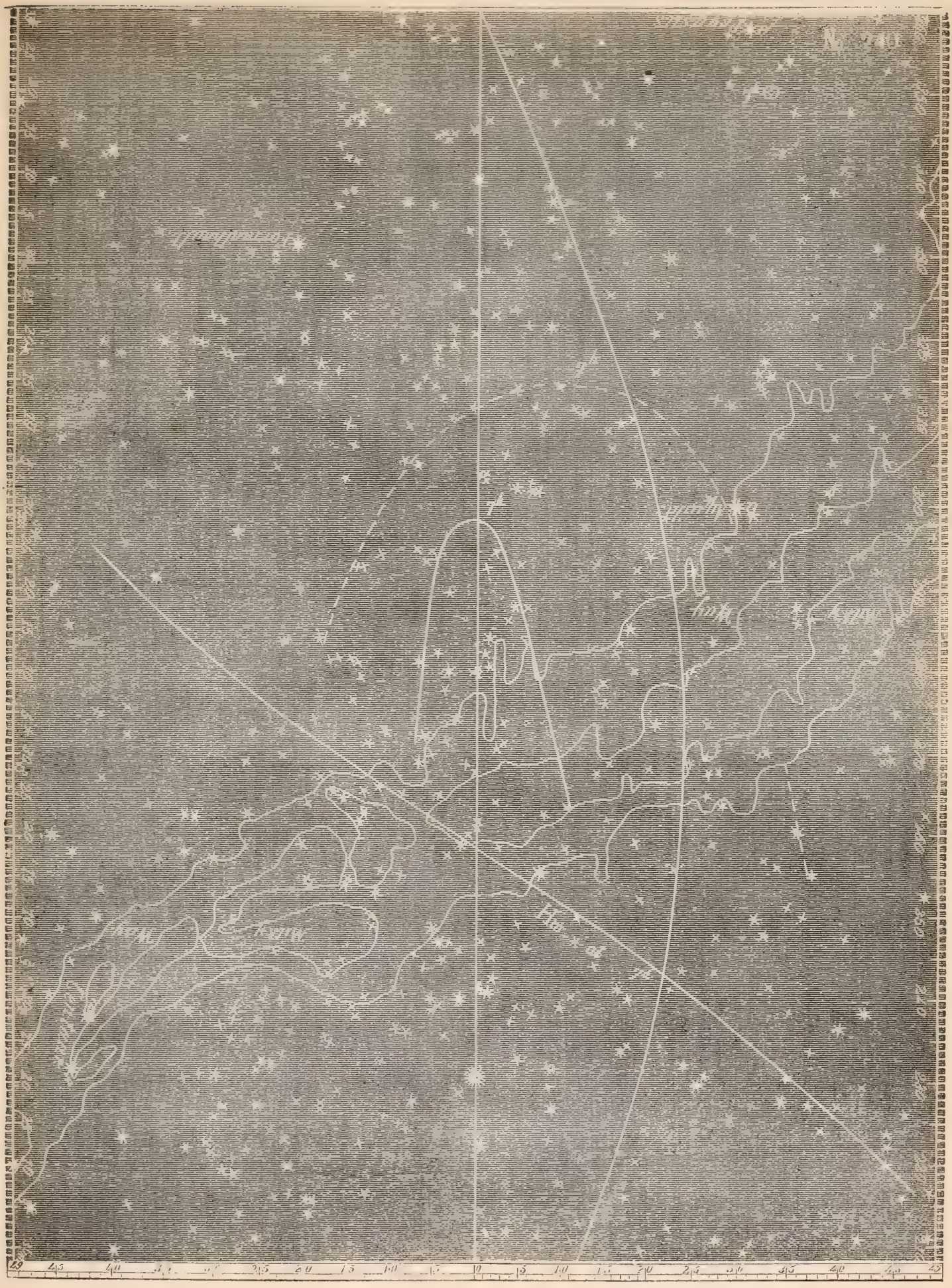


No. 240.

NOVEMBER 13th, 1851: EVENING.

Lat. at 7*h*., 26° 31′ N.: Lon. 147° 27′ W.
Sun set at 5*h*. 7½*m*.
Stronger and Diffuse Light at 7 o'clock.

The 12th was cloudy. Sky, this evening, clear and bright, except some flitting clouds towards the horizon. The observations were, however, unsatisfactory. Jupiter above, and the Milky Way below, interfered.

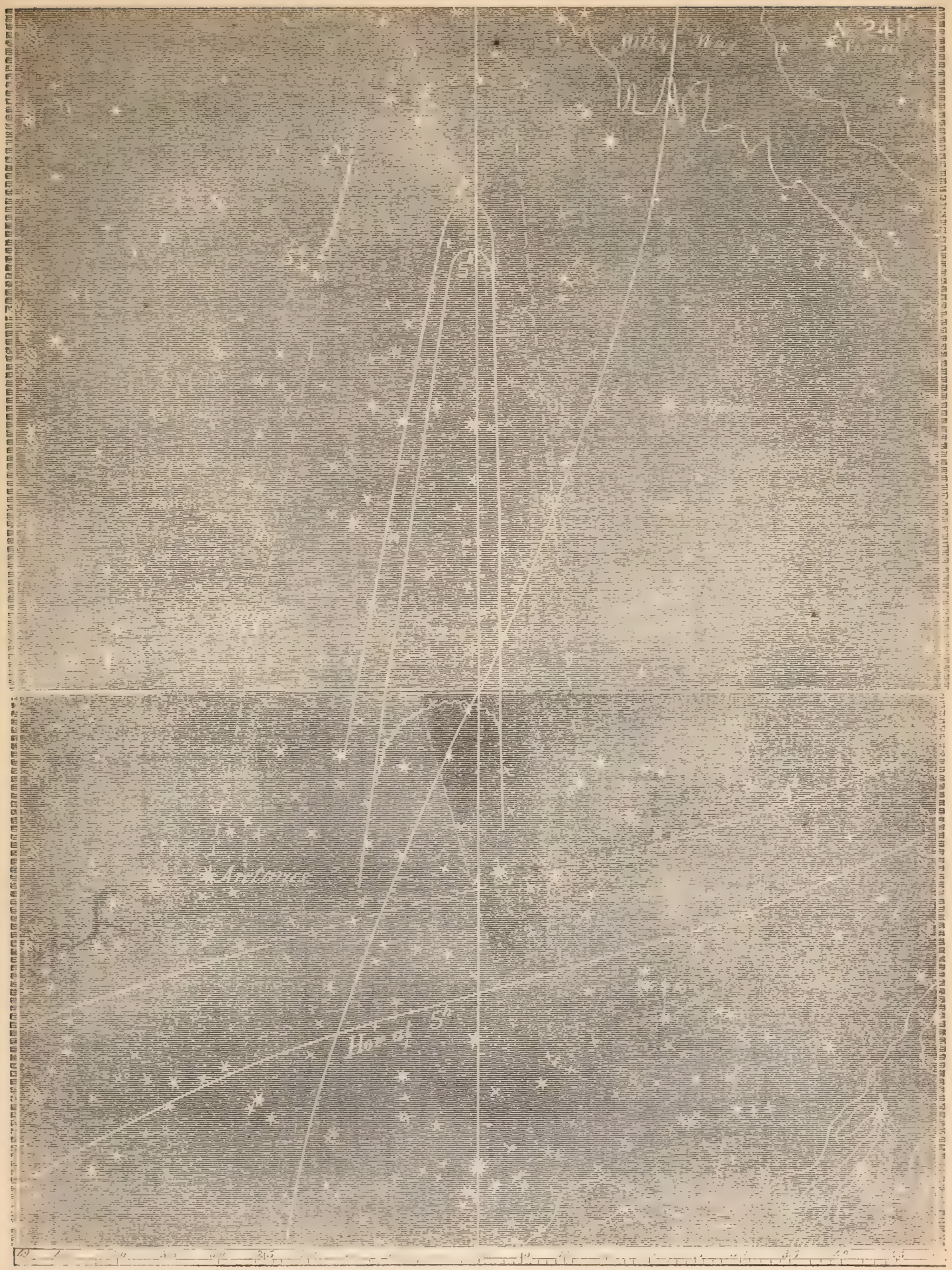


No. 241.

NOVEMBER 20th, 1854: Morning

Lat. at 5^h, 36° 17′ N.: Lon. 125° 51′ W.
Sun rose at 6^h. 16^m.
Stronger Light at 4 and 5 o'clock: Diffuse at 5 o'clock.

Clouds since last observation (13th) till yesterday, which was Sunday. Was on deck this a. m. at 4 o'clock, but found the sky not very favorable; some clouds in the east, and a slight haziness. The Zodiacal Light was dim, but I was able, still, to have a pretty reliable observation. At 5^h the sky was very bright and clear, and the Light very brilliant, especially up as high as the zigzag line x. The Diffuse Light was so badly defined at its upper end, that I was not able to carry its boundaries higher than as in the chart.

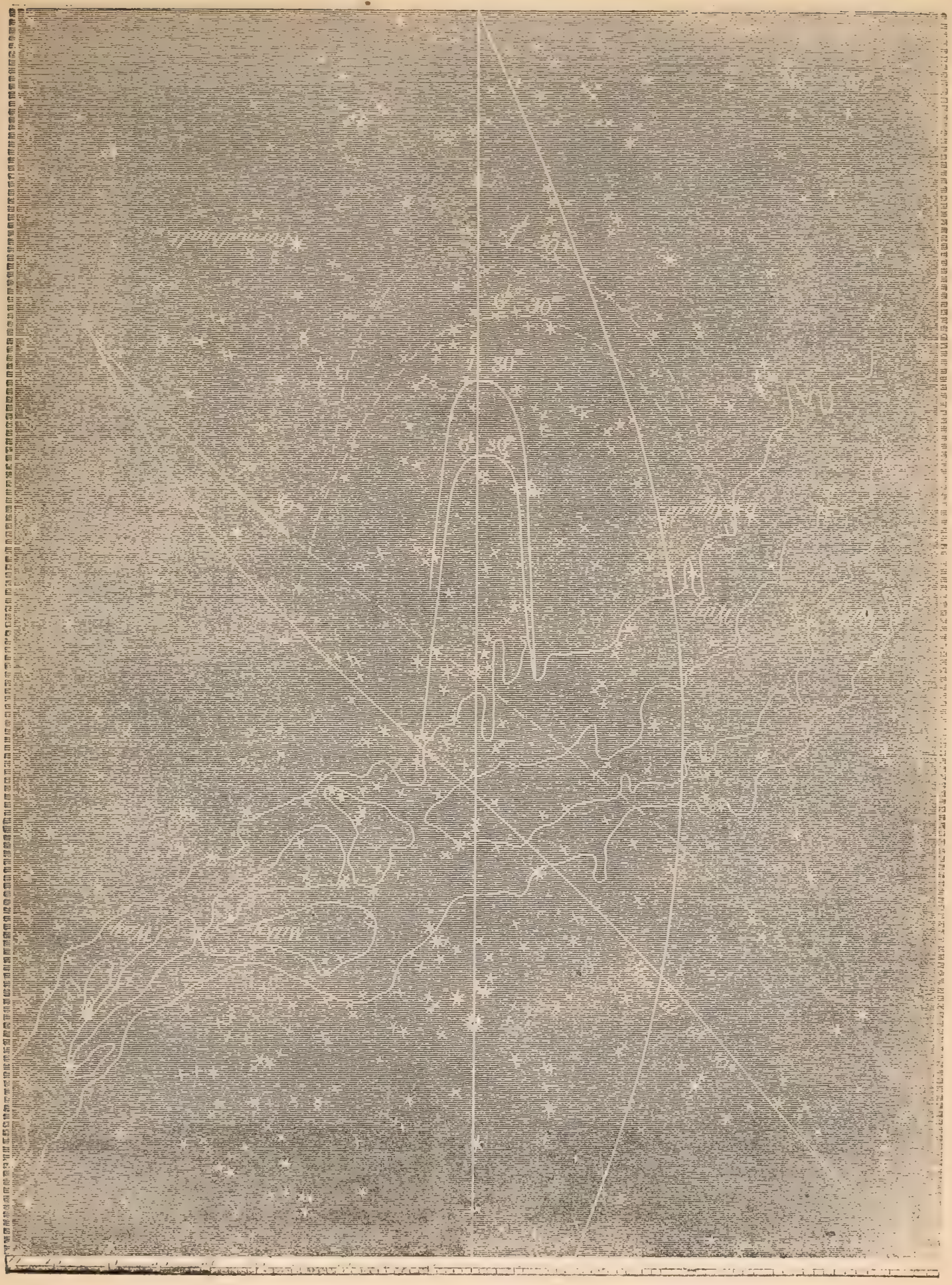

Milky Way
N° 241
Antares
Dec. 0°

No. 242.

NOVEMBER 20th, 1854: Evening.

Lat. at 7^h, 36° 54′ N.: Lon. 125° W.
Sun set at $4^h.\ 42^m.$
Stronger and Diffuse Light at $6^h.\ 30^m.$ and $7^h.\ 30^m.$

Sky very clear and bright. The Zodiacal Light quite distinct at $6^h\ 30^m$, and the Diffuse Light also very well defined. Jupiter is still troublesome, but not so much so as formerly.

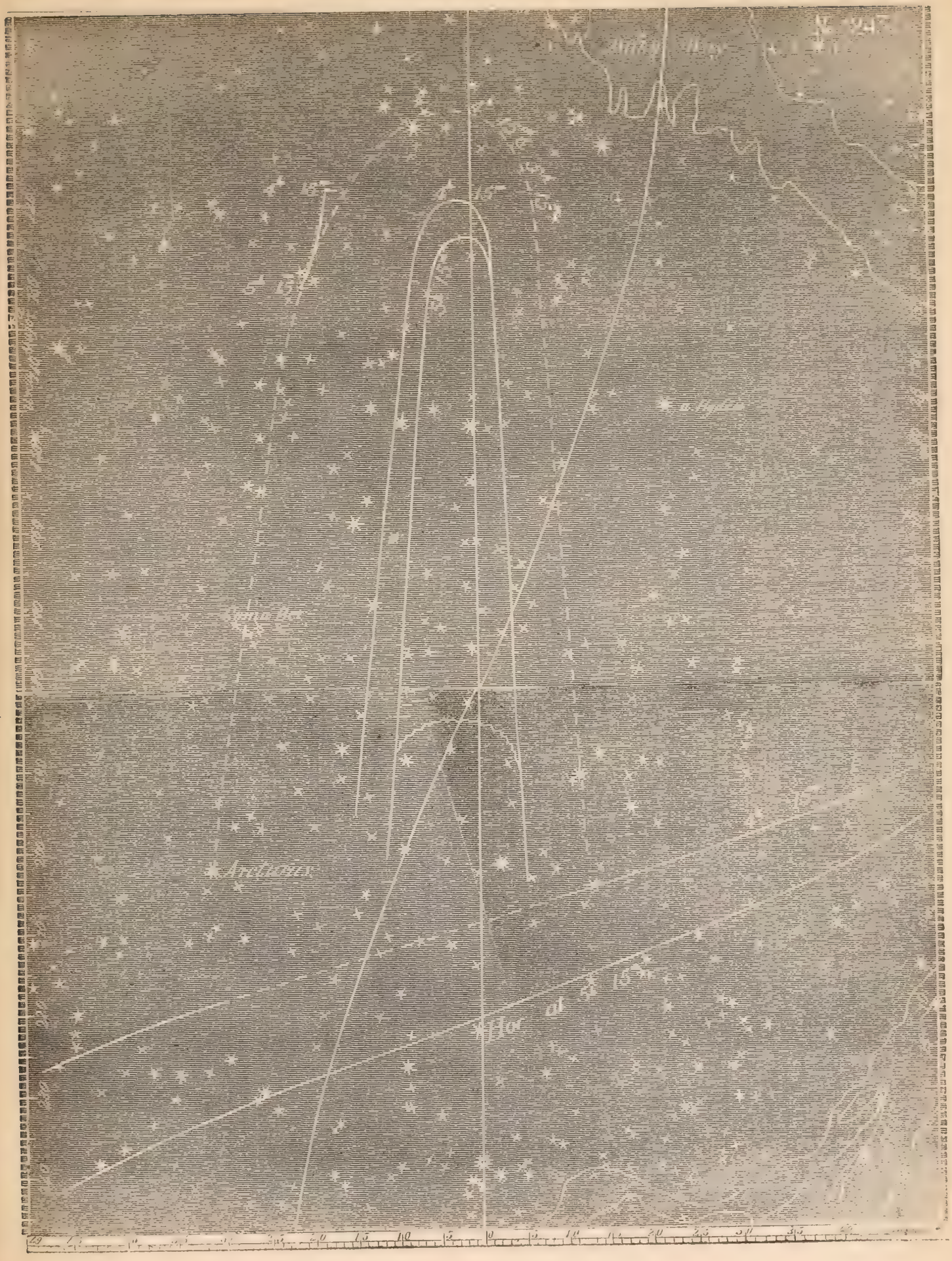


No. 243.

NOVEMBER 21st, 1854: Morning.

Lat. at 4*h*., 37° 16′ N.: Lon. 123° 33′ W.
Sun rose at 6*h*. 5*m*.
Stronger and Diffuse Light at 4*h*. 15*m*. and 5*h*. 15*m*.

A very beautiful and clear morning. The Zodiacal Light very well defined at $4^h\ 15^m$, and very bright and strongly marked at $5^h\ 15^m$; brightest up to the zigzag. I was desirous of watching for pulsations; but I am quite an invalid now, and was fearful of trusting myself too long in the cold morning air and the heavy dew then falling.

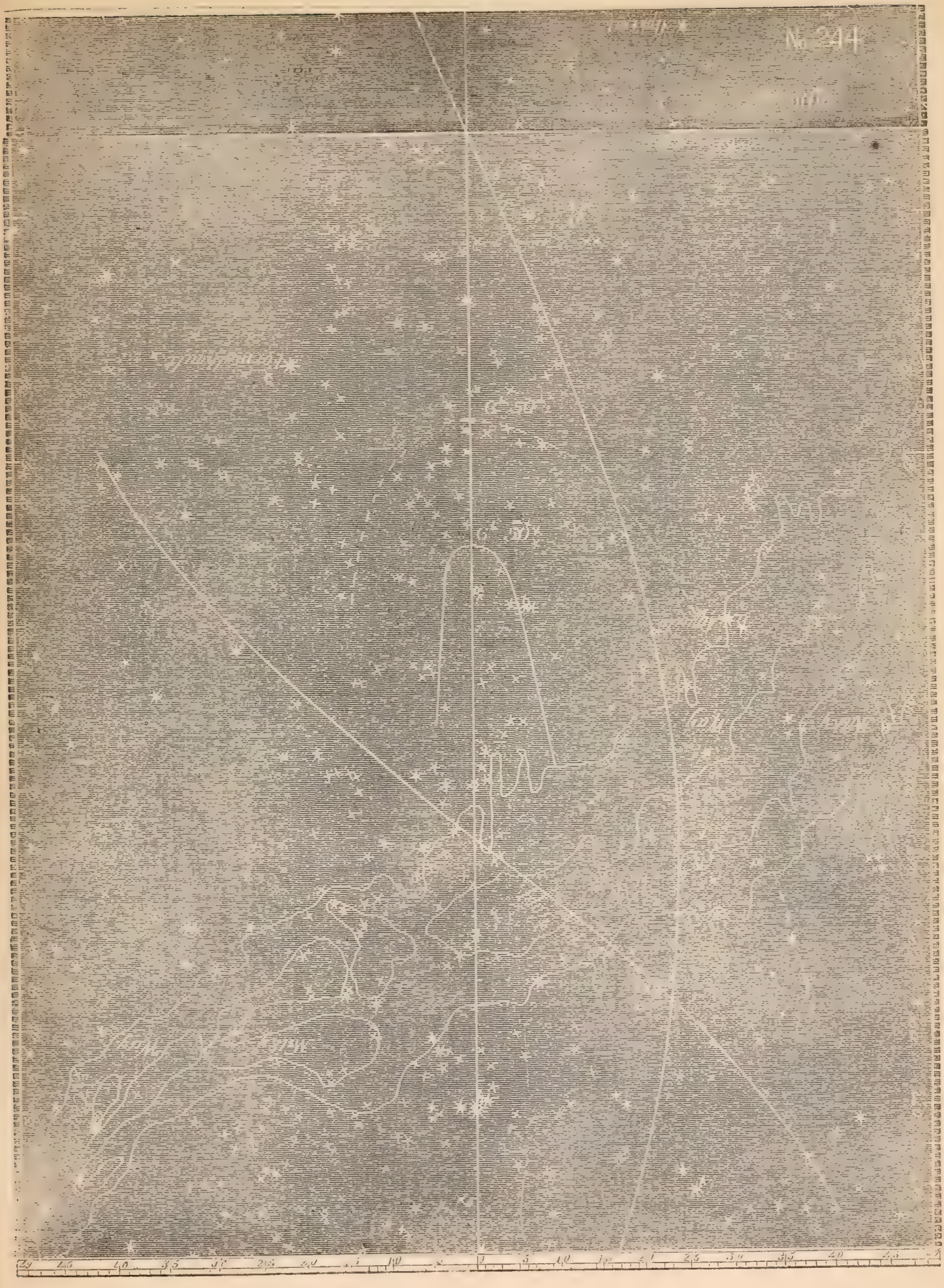

Antares

No. 244.

NOVEMBER 22d, 1854: EVENING.

Lat. 37° 48′ N.: Lon. 122° 21′ W.
Sun set at 4*h*. 4′0*m*.
Stronger and Diffuse Light at 6*h*. 50*m*.

Heavy fog last evening. The moon, this evening, did not set till about 6ʰ 50ᵐ, when I was able to have a tolerably satisfactory observation. A fog then rising rapidly, and obscuring the western sky, was somewhat of a drawback, inasmuch as I had to take the outlines hurriedly before it reached us; but I believe they may be relied on. The fog prevented any thing further through the night.

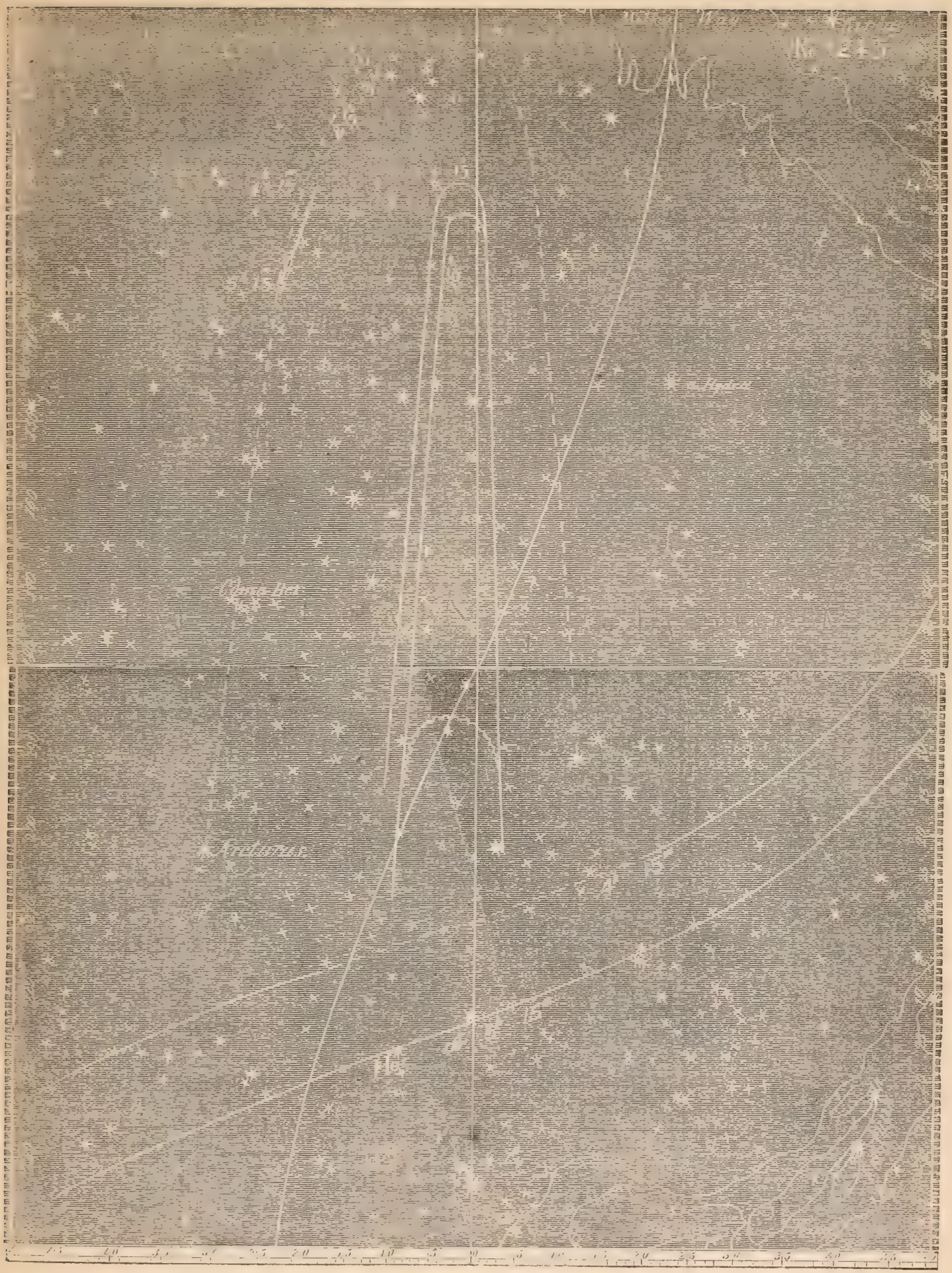

N. 214

No. 245.

NOVEMBER 25th, 1854: MORNING.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun rose at 6*h*. 57*m*.
Stronger and Diffuse Light at 4*h*. 15*m*. and 5*h*. 15*m*.

Fog since last date in the morning. Moon in the evening. This a. m. sky not very bright: the Zodiacal Light, however, giving very good outlines. At $5^h\ 15^m$ it was somewhat dull; brightest up to the zigzag.

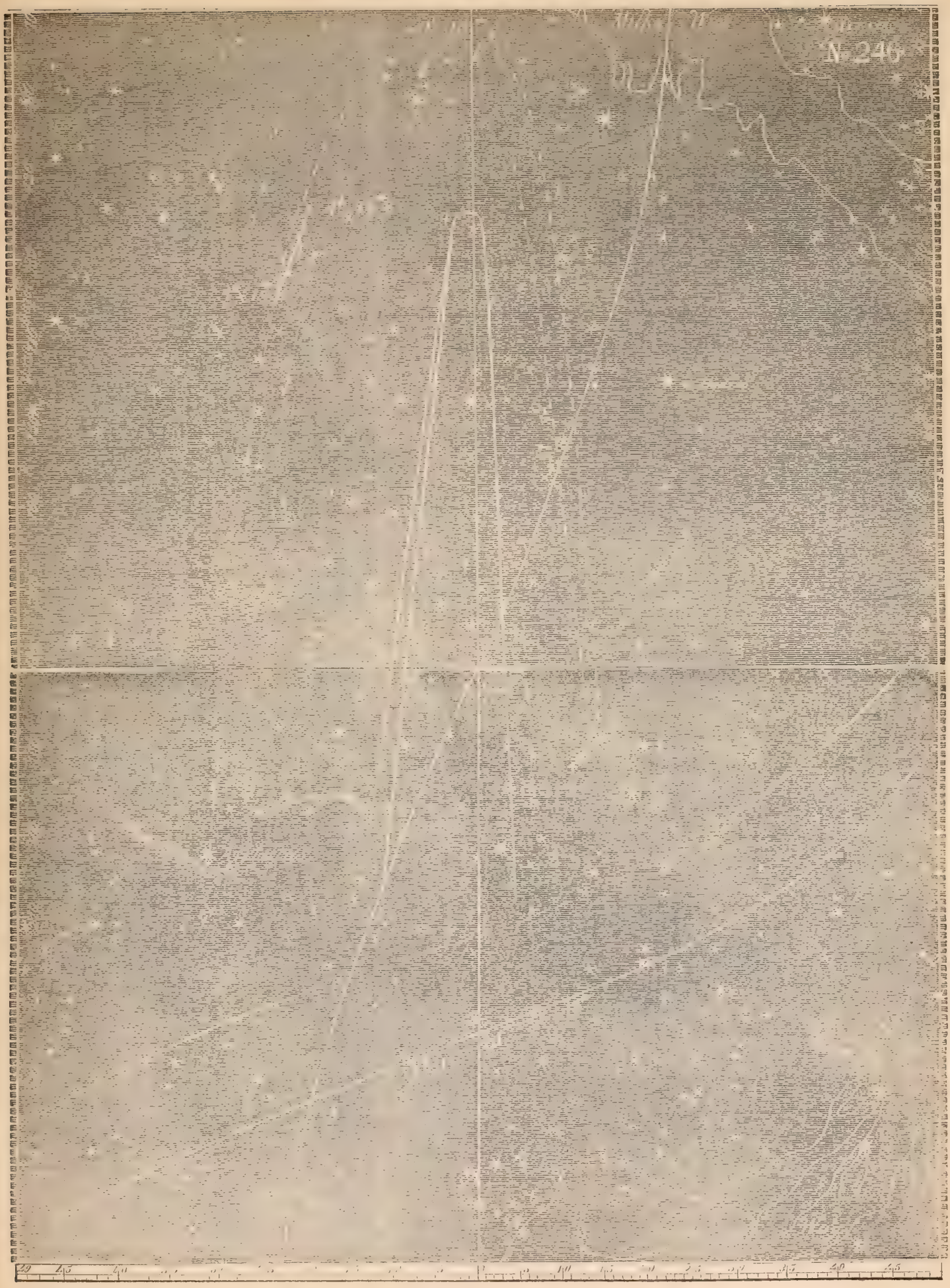

Procyon
Sirius
Orion
Aldebaran

No. 246.

NOVEMBER 27th, 1854: MORNING.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun rose at 6*h*. 58*m*.
Stronger and Diffuse Light at 4*h*. 15*m*. and 5*h*. 15*m*.

(Yesterday was Sunday.) The sky, at this place [Benicia, California], is perfect; a clear deep blue during the day, and stars brilliant at night. The Zodiacal Light, at $4^h\ 15^m$, was not bright, but had its outlines very well defined. At $5^h\ 15^m$, very bright. At that hour I could not get the upper limit of the Diffuse Light, which was also not very distinct at $4^h\ 15^m$. I looked to see whether there were pulsations at $5^h\ 15^m$, the circumstances being so favorable for observing them, if there were any; but none could be perceived.

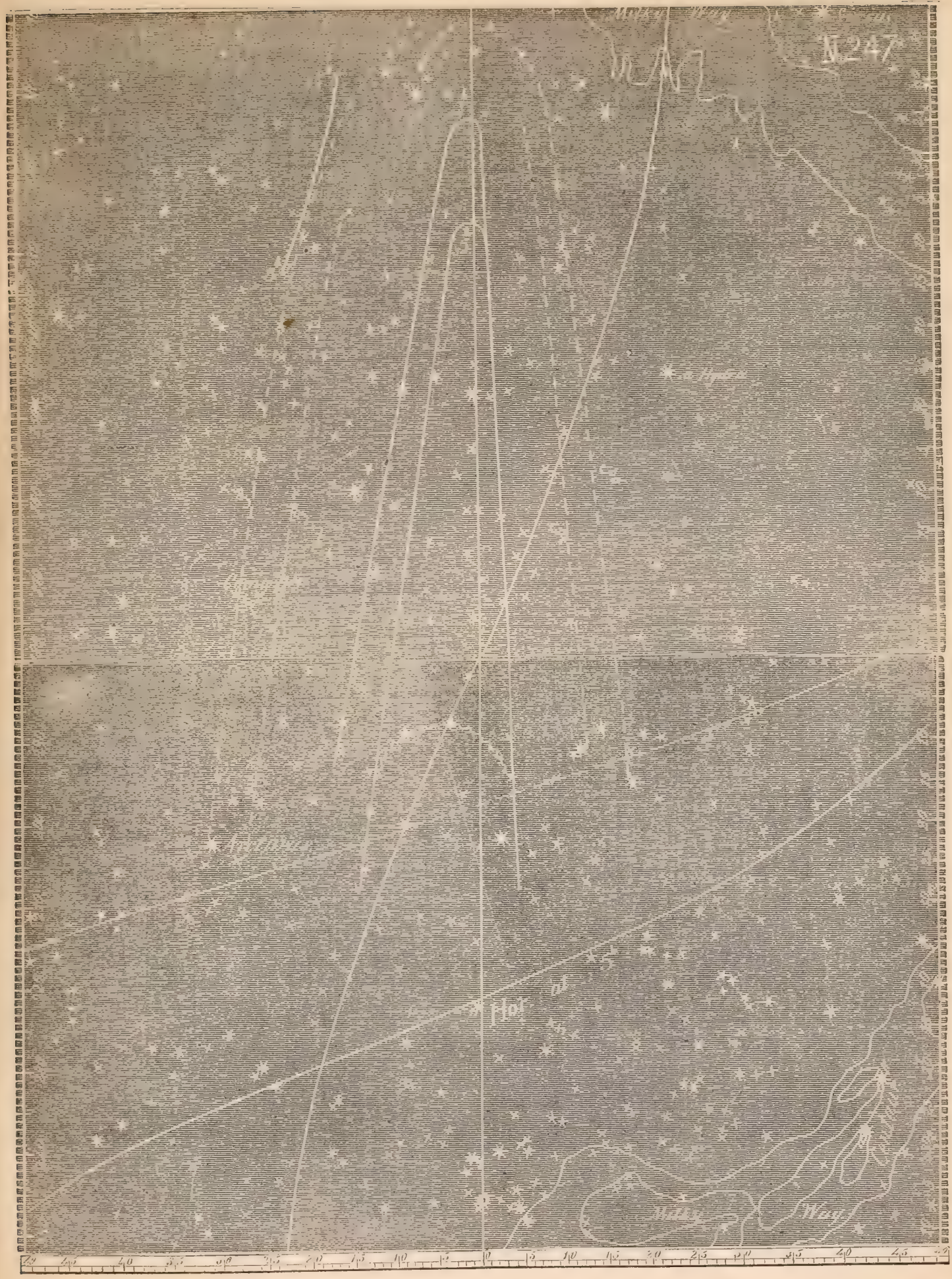

N 246

No. 247.

NOVEMBER 28th, 1854: MORNING.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun rose 6*h*. 59*m*.
Stronger and Diffuse Light at 3 and 5 o'clock.

Sky very brilliant. Rose at 3^h, and found the Zodiacal Light, though dim, yet quite distinct. The outlines were not very well marked; but I was still able to get them reliably. At 5^h the Light was very bright, especially up to the zigzag; but I was not able to see any pulsations. The morning was remarkably favorable for observations.

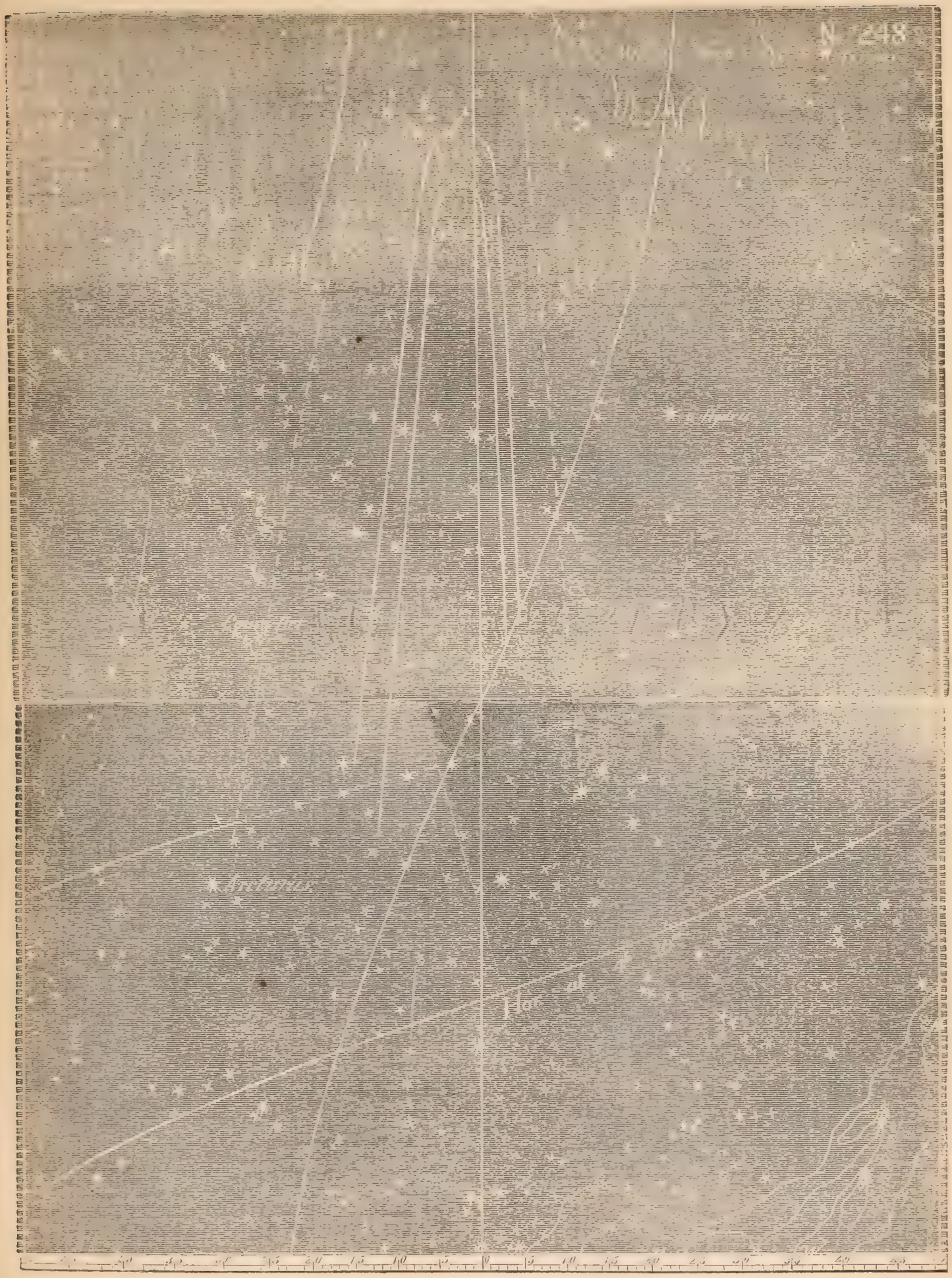

Milky Way

No. 248.

NOVEMBER 29th, 1854: Morning.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun rose at 7*h*. ½*m*
Stronger Light at 2*h*. and 4*h*. 30*m*.: Diffuse at 4*h*. 30*m*.

Moon set a few minutes before 2 o'clock. At 2^h went on deck, and found the Zodiacal Light distinctly marked in the sky, though it was difficult to get its outlines. Blowing violently; but sky perfectly clear and brilliant. At $3^h\ 30^m$ again on deck, but found the sky clouded over. At $4^h\ 30^m$ it had cleared off again, except towards the horizon, and I was able to get reliable boundaries, except for the upper end of the Diffuse Light. The upper end of the Stronger is also now badly defined.

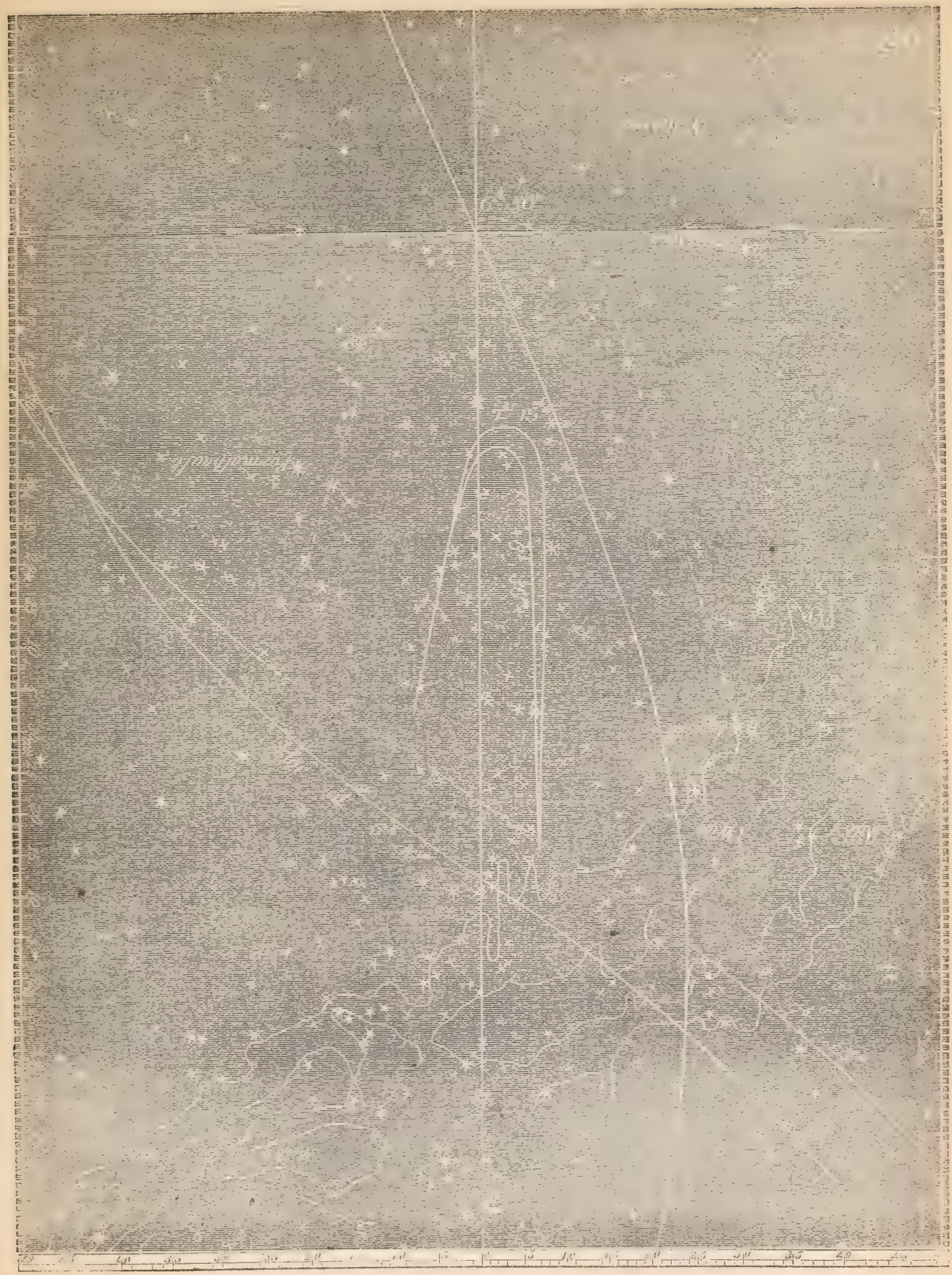

N 1248
Arcturus
Antares

No. 249.

DECEMBER 7th, 1854: EVENING.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun set at $4^h.\ 35\frac{1}{2}^m$.
Stronger Light at $6^h.\ 30^m.$ and $7^h.\ 15^m.$: Diffuse $6^h.\ 30^m.$

Clouds since my last date (November 29th), until this evening. Sky, to-night, very bright and clear, and I had a good observation at $6^h\ 30^m$: not so good at $7^h\ 15^m$, as the moon, then approaching the horizon, hurried me.

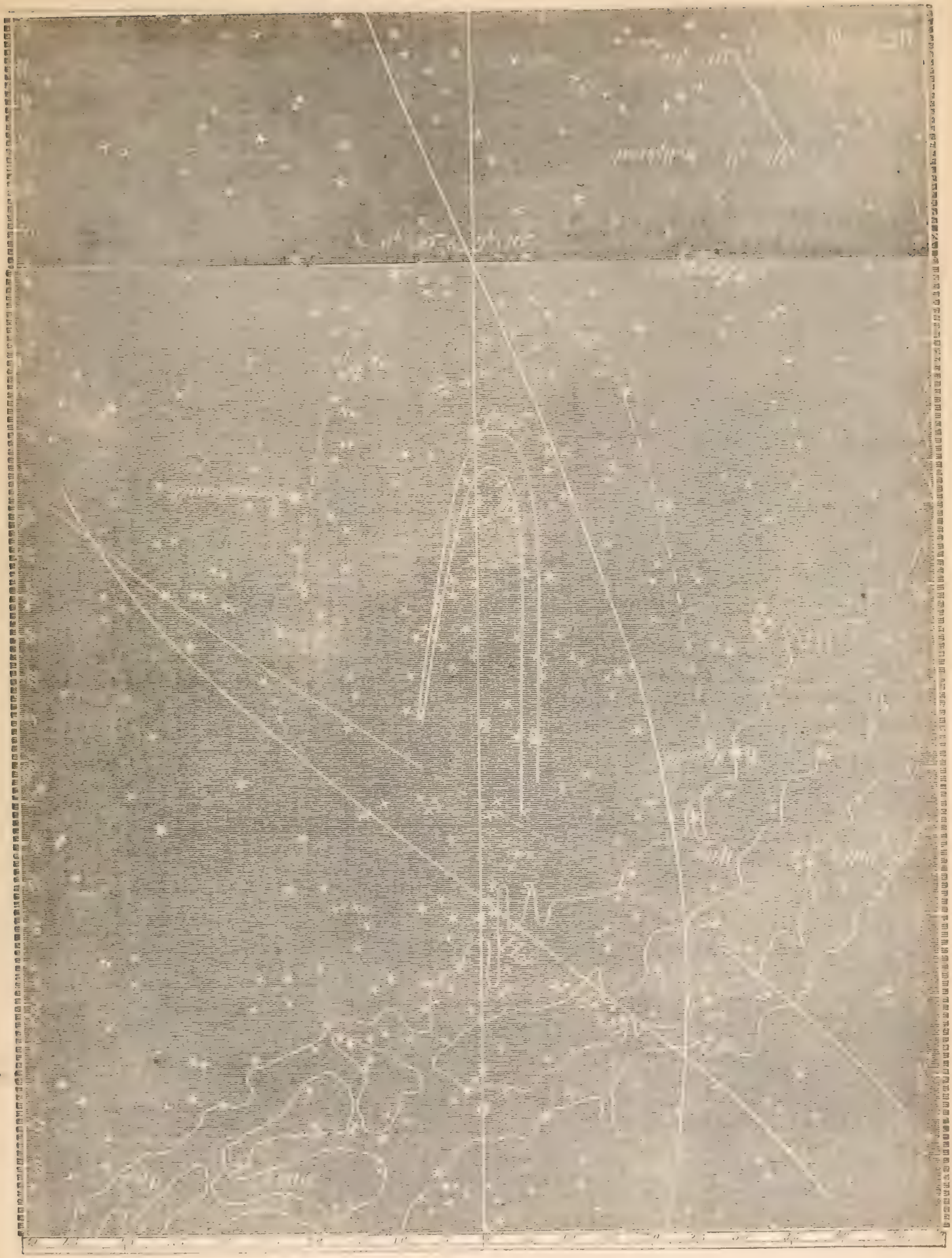


No. 250.

DECEMBER 8th, 1854: EVENING.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun set at 4*h*. 36*m*.
Stronger and Diffuse Light at 6*h*. 30*m*. and 7*h*. 30*m*.

Sky remarkably clear and brilliant, and extremely favorable for observations. At 6^h 30^m the outlines were all well marked, except the upper end of the Diffuse Light. At 7^h 30^m the Stronger Light was dim, but its boundaries were still pretty easily made out.



No. 251.

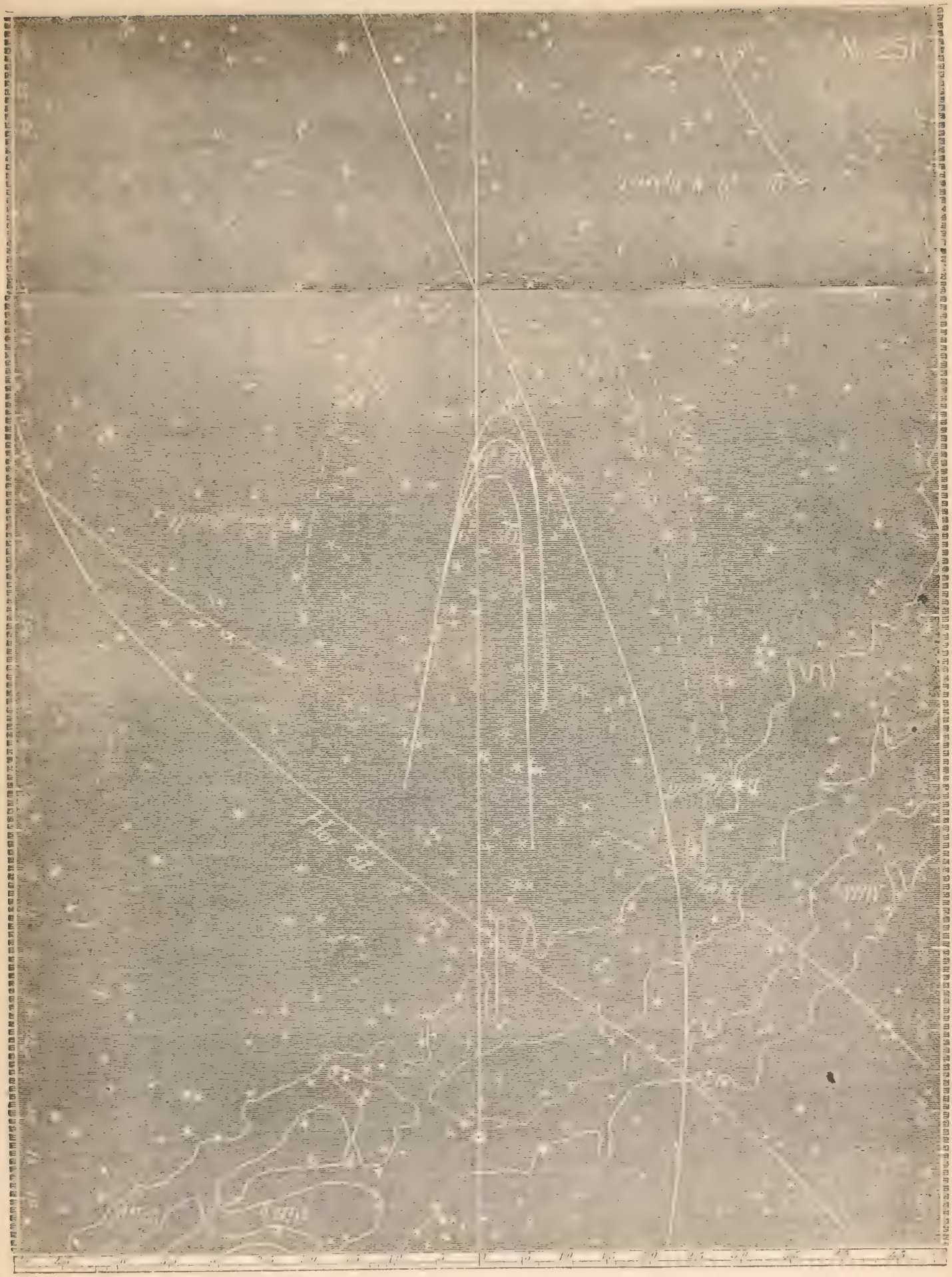
DECEMBER 9th, 1854: Evening.

Lat. 38° 2′ N.: Lon. 122° 7′ W.

Sun set at 4*h*. 36*m*.

Stronger and Diffuse Light at { 6*h*. 30*m*. / 7 30 / 8 0

Sky brilliant. The outlines of both Stronger and Diffuse Light were remarkably well marked at $6^h\ 30^m$; also, at $7^h\ 30^m$, very distinct; at 8^h, dimmed considerably, but outline still good; at $8^h\ 30^m$, Light still distinct: boundaries not easily made out, but seemingly as at 8 o'clock.

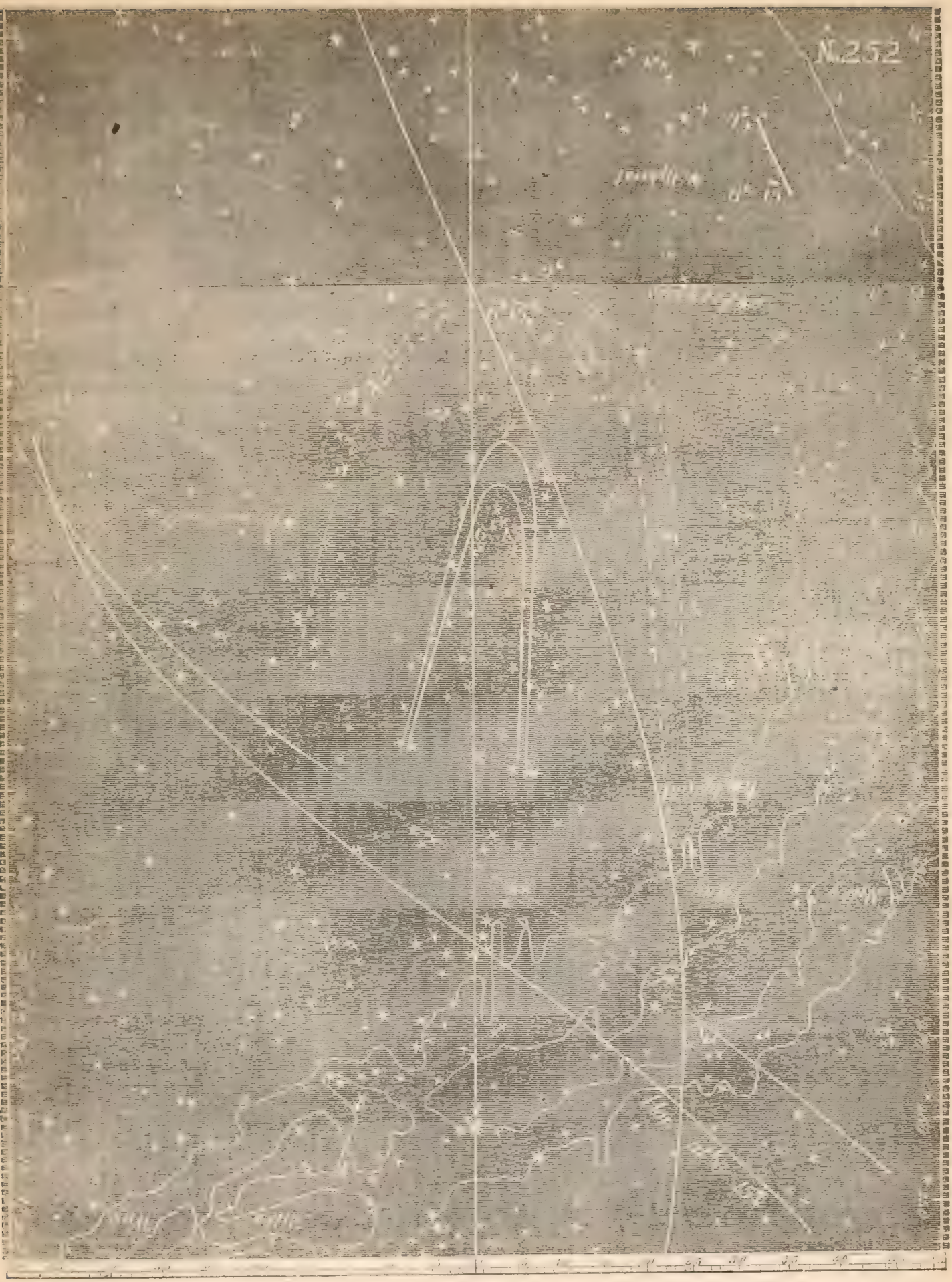


No. 252.

DECEMBER 11th, 1854 (10th was Sunday): Evening.

Lat. 38° 2′ N.: Lon. 122° 7′ W.
Sun set at 4*h*. 36½*m*.
Stronger and Diffuse Light at 6*h*. 15*m*. and 7*h*.

Sky clear and very brilliant. The Zodiacal Light quite distinct at $6^h\ 15^m$: stronger at 7^h; at $7^h\ 30^m$, strong, and outlines apparently the same as at 7^h.


N.252

No. 253.

DECEMBER 12th, 1854: EVENING.

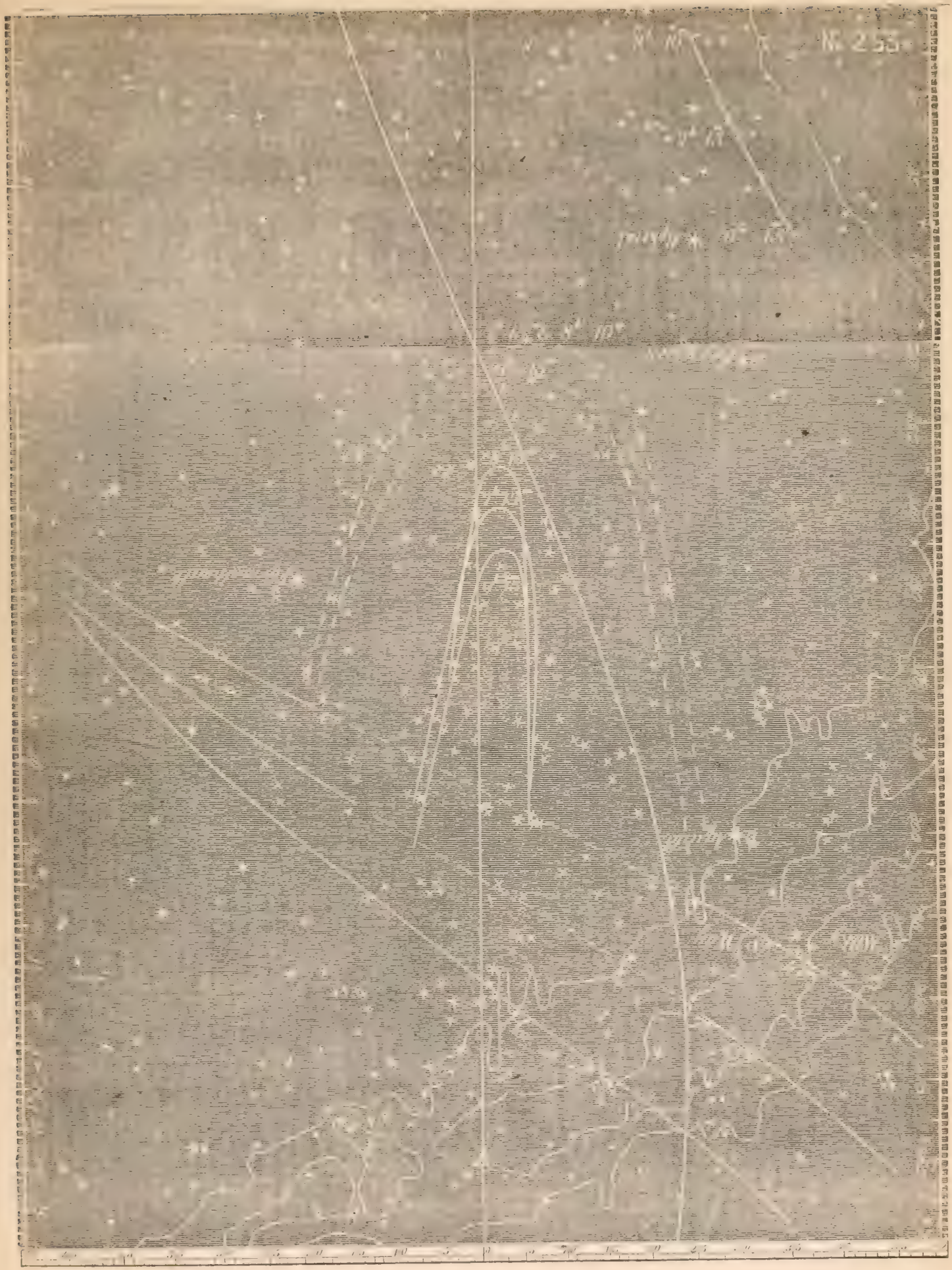
Lat. 38° 2′ N.: Lon. 122° 7′ W.

Sun set at 4*h*. 37*m*.

Stronger and Diffuse Light at { 6*h*. 15*m*. / 7 15 / 8 10

Sky clear, and very fine for observations. At 6^h 15^m, boundaries very well marked. I was particularly careful this evening with reference to the sliding over of the Stronger Light as the night advanced. The sky was very favorable for nice observations. The result is in the chart. The query is: Is the spreading out of the southern or left boundary owing to the Zodiacal Light now crossing the ecliptic? or is it owing to the position at which we view the Light? The fact that, as the night advances, the southern boundary slides so as to approach nearer to a parallelism with the ecliptic, seems to give an affirmative answer to the latter of the above queries.

At 8^h 10^m, the Light had dimmed, but was still bright; and at 8^h 21^m, it still gave well marked boundaries, the same as at 8^h 10^m.


No. 253

No. 254.

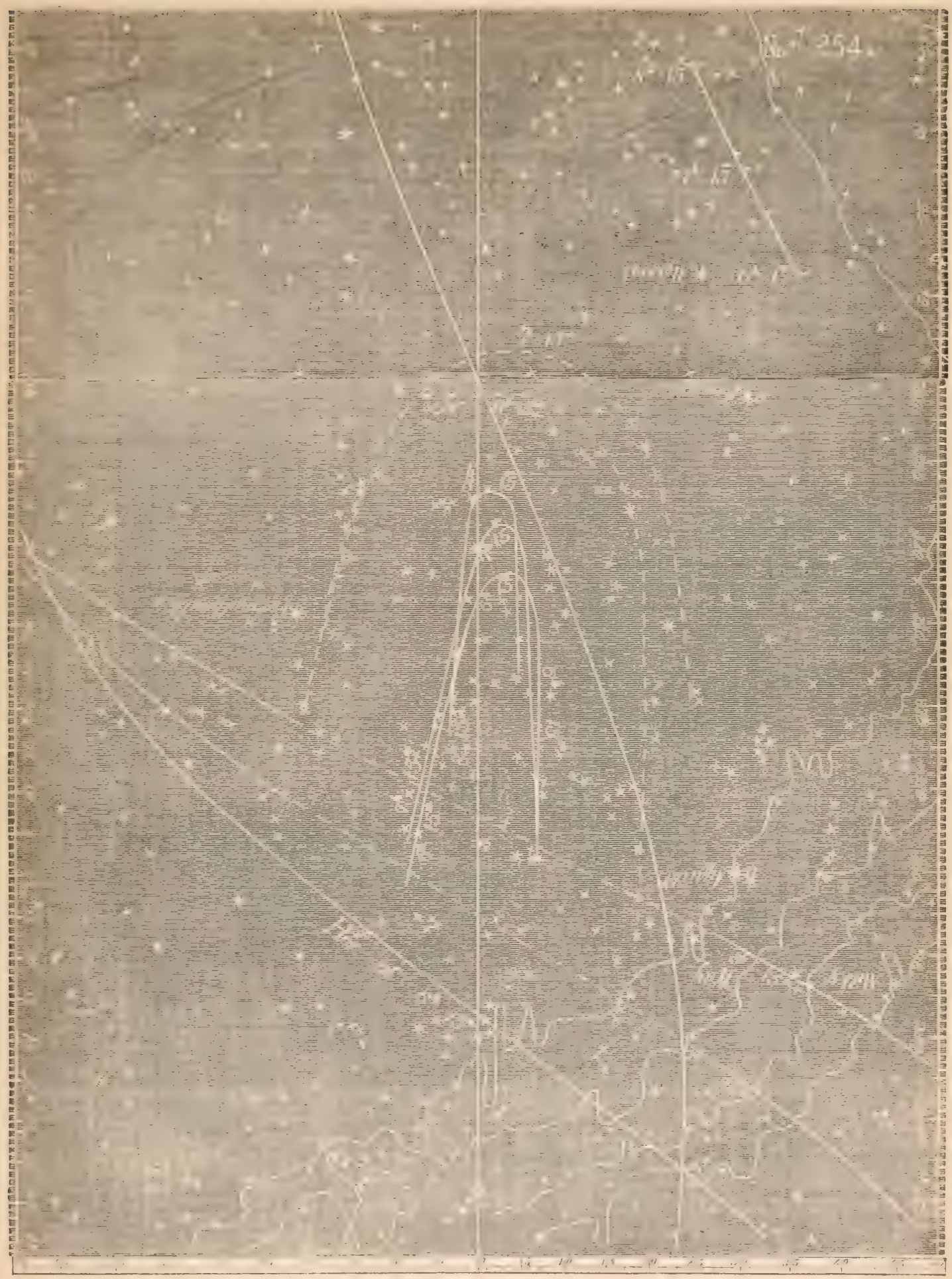
DECEMBER 13th, 1854: EVENING.

Lat. 37° 48′ N.: Lon. 122° 21′ W.

Sun set at 4*h*. 38*m*.

Stronger Light at { 6*h*. 15*m*. / 7 15 / 8 0 } Diffuse Light at 6*h*. 15*m*. and 7*h*. 15*m*.

Sky clear, and very brilliant. The Zodiacal Light quite bright at 6^h 15^m. At 8^h 15^m, dim, but distinctly marked. Had some difficulty in getting outlines at that hour, but believe those in the chart may be relied on. The Diffuse was about the same as at 7^h 15^m. At 9^h, the Light could still be made out, and its upper end had evidently ascended up as high as 6 and 8 Piscium, but I could not get reliable boundaries. The night, at that hour, was still very brilliant, and favorable for observations.



No. 255.

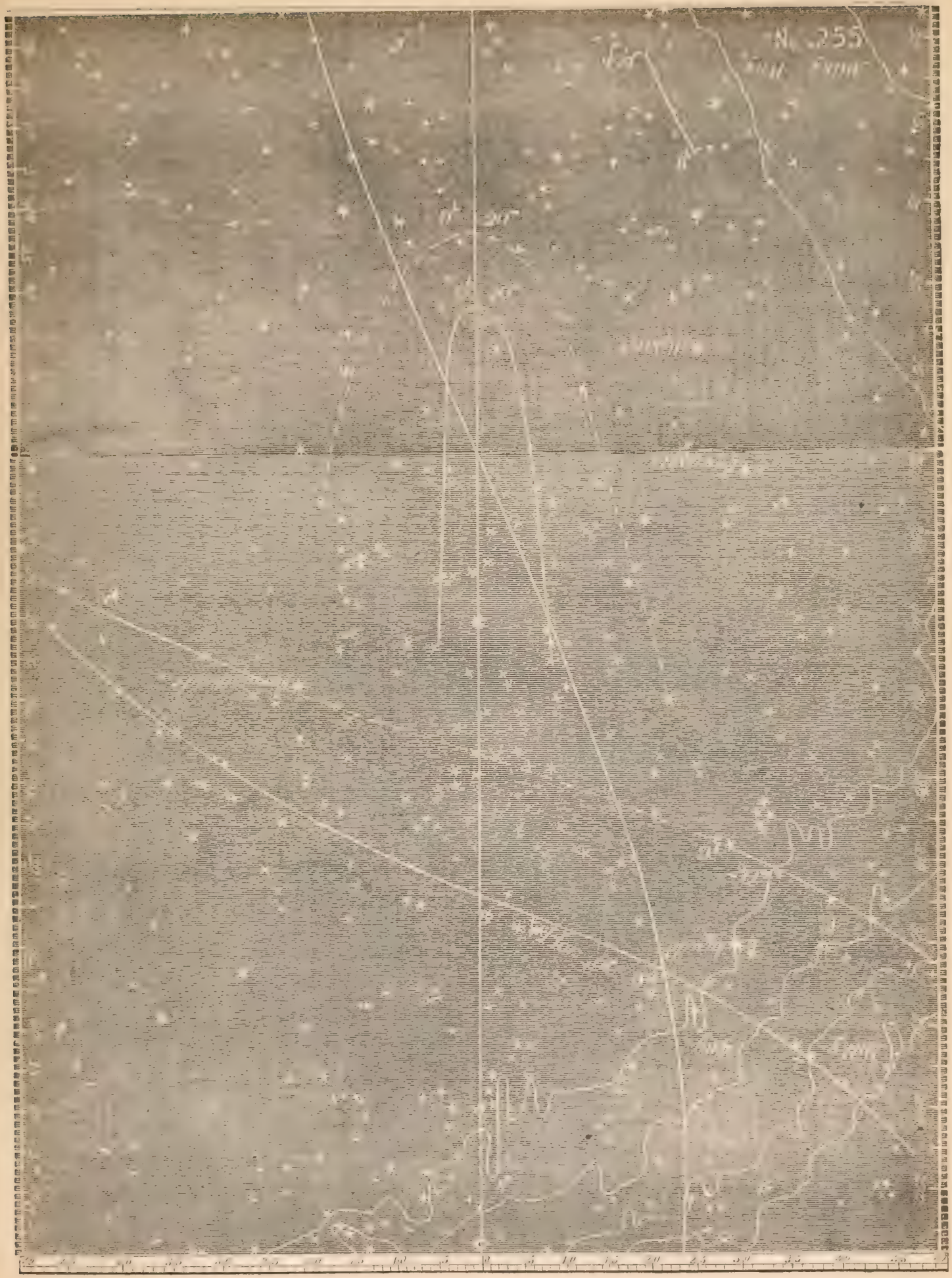
DECEMBER 15th, 1854: Evening.

Lat. 37° 48′ N.: Lon. 122° 21′ W.
Sun set at 4*h*. 39*m*.
Stronger and Diffuse Light at 9*h*. 20*m*.

Last evening too hazy for reliable results. So, also, at the early part of this evening.

I have for three or four nights past noticed what seemed to be a great ascent of the Zodiacal Light in the sky towards 9 o'clock; but the Light was so dim, and the appearance was so strange and unusual, that I was unwilling to make any record of it, until further and more decisive observations; so anxious am I to guard against optical illusions. But this evening, the sky at 9^h being particularly clear and favorable, this extended Light was so decided that I could no longer hesitate. To make the matter more certain, however, I took the quartermaster on watch, and, pointing out an extent of one quarter of the sky southward of the Milky Way, asked him to say whether he thought any one part was brighter than the rest. He replied, "Oh yes, and I can tell you at once where it is; for I have been observing it several nights." He then gave the outlines as I have drawn them in the chart for the Diffuse Light, except that he did not carry them higher than 71 Piscium, near where I have made the Stronger Light terminate. I had no difficulty in making out the boundaries of both Diffuse and Stronger Light.

At 10^h 30^m there was only a slight discoloration of the sky in that portion of it lying within the limits given at 9^h 20^m, and no reliable boundaries could be drawn.


N. 255

No. 256.

DECEMBER 16th, 1854: Evening.

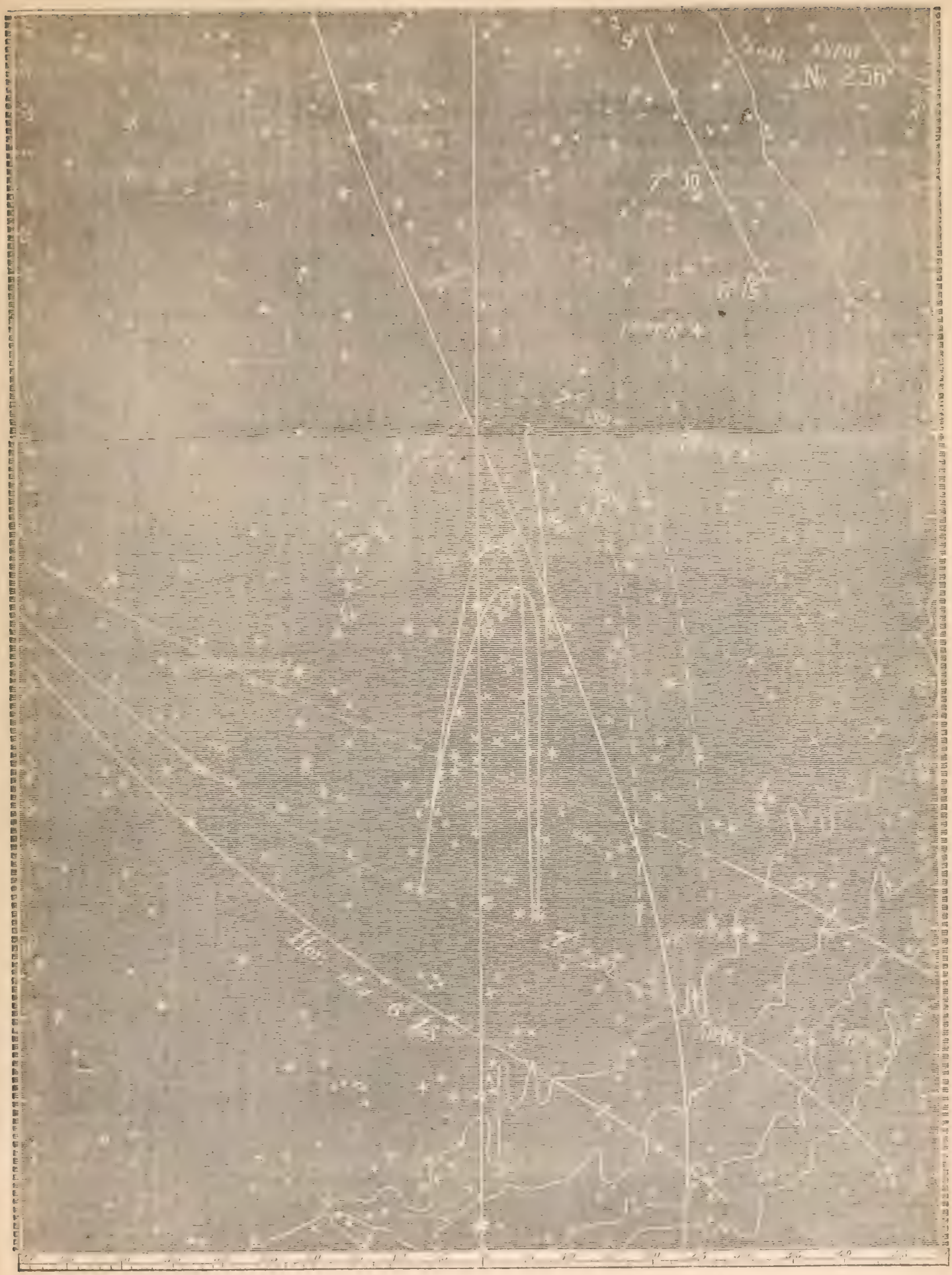
Lat. at $8h.$, 37° 21′ N.: Lon. 122° 45′ W.

Sun set at $4h.\ 40m.$

Stronger Light at $\left\{\begin{matrix} 6h.\ 25m. \\ 7\ \ 30 \\ 9\ \ 0 \end{matrix}\right\}$ Diffuse, $6h.\ 25m.$ and $7h.\ 30m.$

Sun's Lon. 263° 15′.

The sky, this evening, at $6^h\ 25^m$ clear, but the stars not bright, and the time not the most favorable for observations. Had some difficulty in getting outlines. Dim still at $7^h\ 30^m$. At 9^h, I could perceive that the Stronger Light had shot up, as noticed for some evenings previous (see last entry); but I was able to get only the upper boundary, some clouds, rapidly ascending, having shut out the lower one.

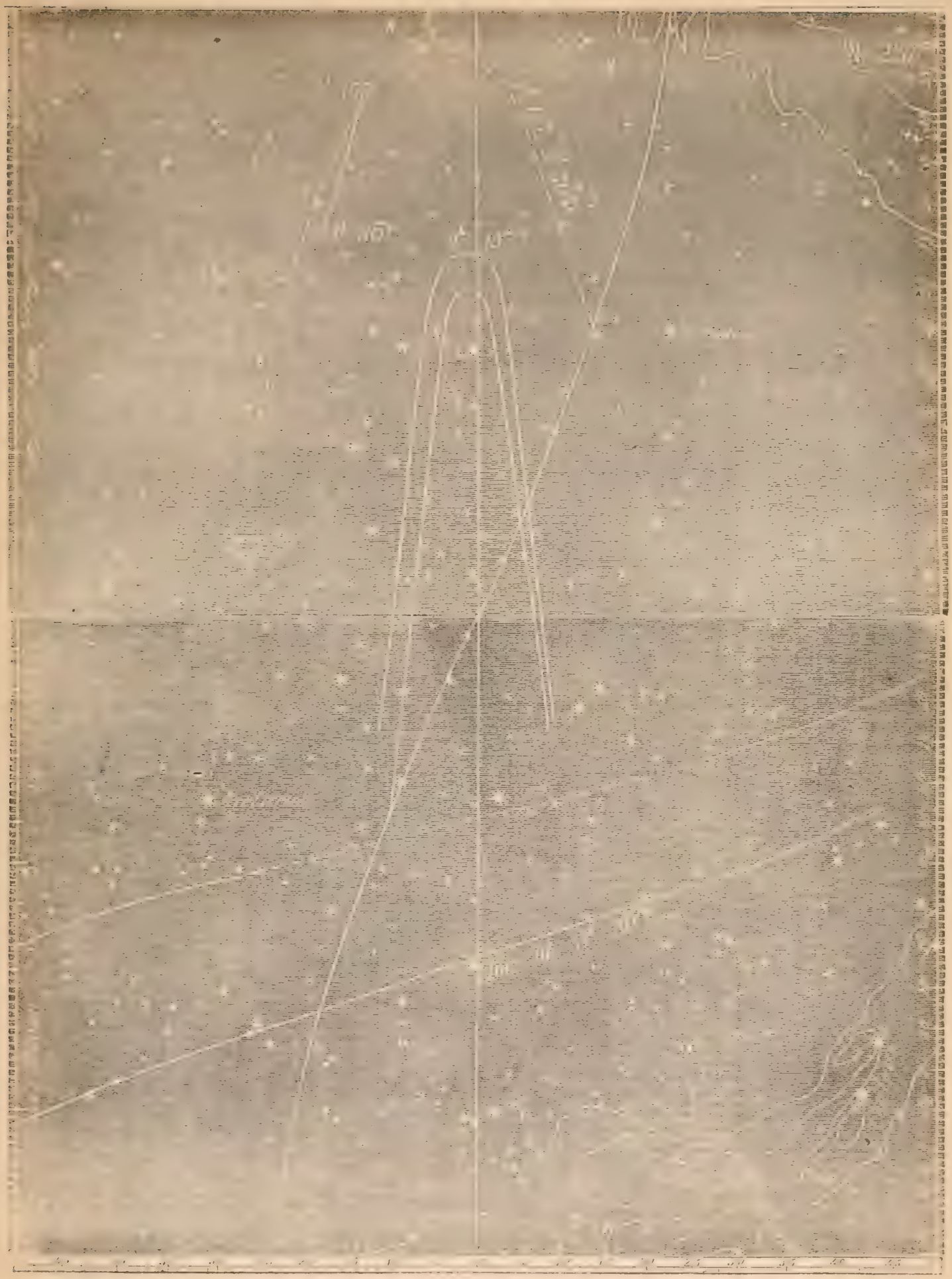

N. 256

No. 257.

DECEMBER 18th, 1854 : Morning.

Lat. at 3*h*., 33° 58′ N. : Lon. 120° 26′ W.
Sun rose at 7*h*. 5*m*.
Stronger and Diffuse Light at 2*h*. 15*m*. and 3*h*. 30*m*.
Sun's Lon. 266° 18′.

Clouds yesterday; also on Sunday. Sky this morning very clear and brilliant above; a few clouds near the horizon. Was on deck at $2^h\ 10^m$, and found the Zodiacal Light very distinct, with boundaries well defined. At $3^h\ 30^m$ the Light was not as strong as at $2^h\ 15^m$, and the outlines were not so well marked, although the sky was as clear and the stars as brilliant as at the previous observation. I could not tell what caused the difference. The Diffuse was seemingly as at $2^h\ 15^m$: its upper end at neither time clearly defined.



No. 258.

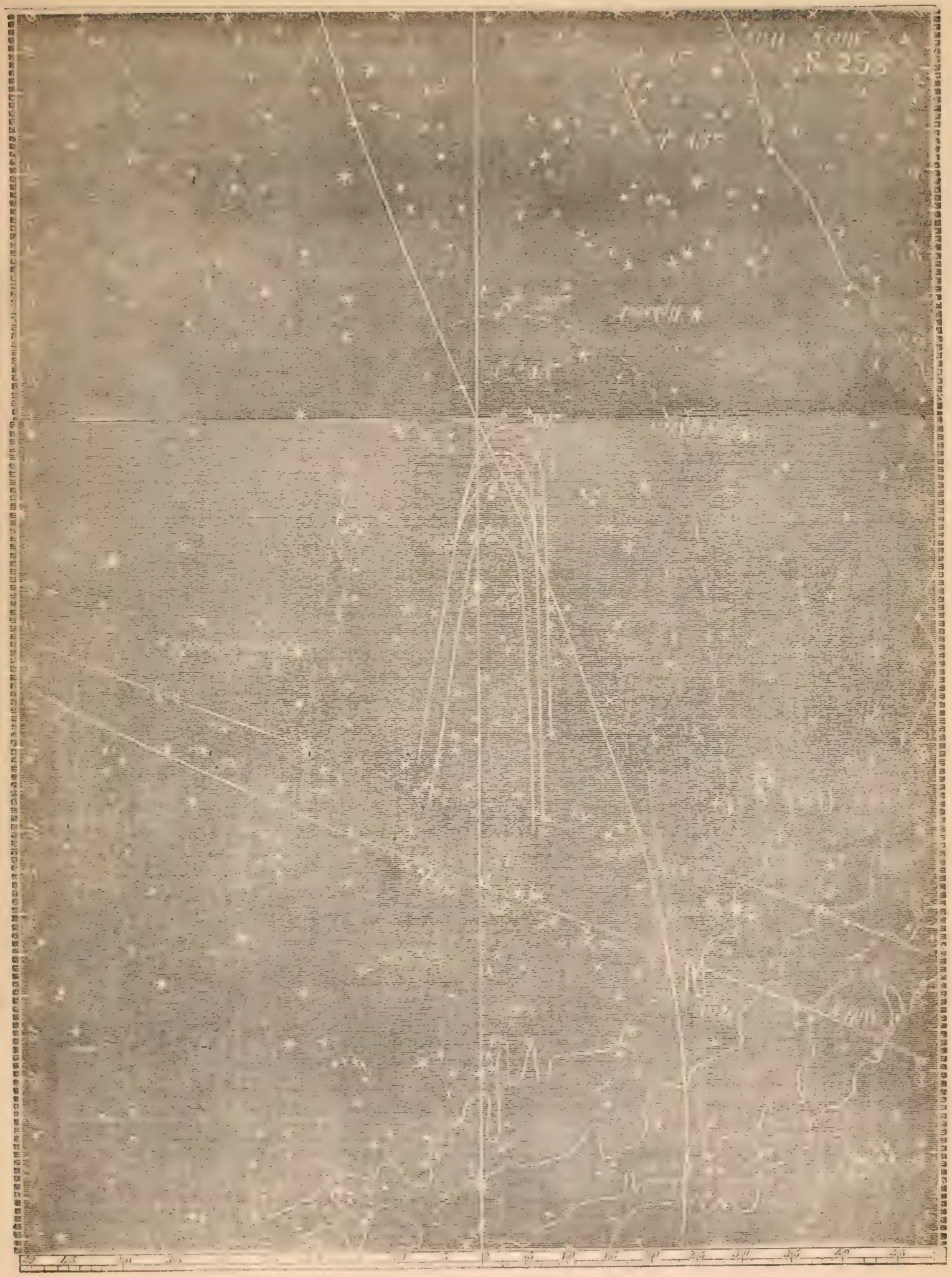
DECEMBER 18th, 1854 : Evening.

Lat. at 8*h*., 31° 43′ N. : Lon. 120° 3′ W.

Sun set, 4*h*. 55*m*.

Stronger Light { 7*h*. 45*m*. / 8 30 } Diffuse, 7*h*. 45*m*. and 8*h*. 30*m*.

Cloudy till near $7^h\ 45^m$, when the sky became favorable for observations. I thought, this evening, that there were probably pulsations ; and for a while made record of what seemed to be such : but all was so uncertain, that I feel unwilling to copy them, but concluded to wait for further observations. They seemed to have *a* and *b* for their boundaries: and finally, at $8^h\ 7^m$, the Light seemed to remain permanently at *c*—its boundaries permanent, but pulsations in intensity still continuing. At $8^h\ 30^m$ it was still distinct, though dimmed considerably.


N 293

No. 259.

DECEMBER 19th, 1854.: Morning.

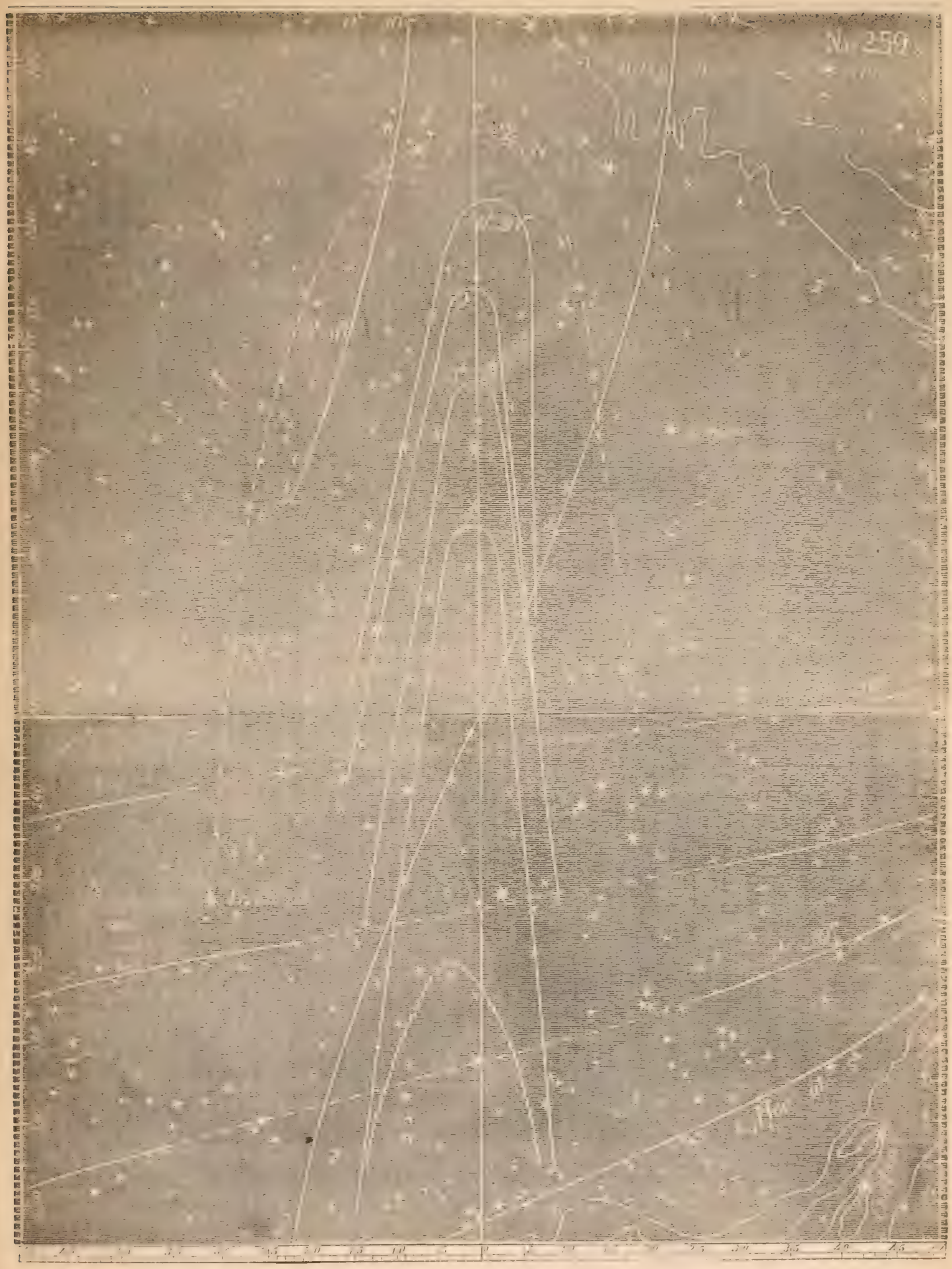
Lat. at 4*h*., 31° 2′ N.: Lon. 119° 23′ W.

Sun rose at 6*h*. 57*m*.

Stronger and Diffuse Light { 2*h*. 0*m*. / 3 30 / 5 0

Sun's Lon. 267° 19′.

Sky, all morning, remarkably fine for observations. Was on deck at half an hour after midnight, and found the eastern Zodiacal Light distinctly and unmistakably marked in the sky, though faint, and it was somewhat difficult to get outlines. Thought also that, at that hour, I could trace a remnant of the same Light in the western sky; but it was not decided, and gave no reliable boundaries. At 2^h the eastern Zodiacal Light was bright, and at 3^h 30^m quite so. At 5^h it was as brilliant as I have ever seen it, and was especially so within the zigzag, where this effulgent Light had more of a cone shape than I ever saw it have before.


No. 259.

No. 260.

DECEMBER 19th, 1854: Evening.

Lat. at 8*h*., 20° 39′ N.: Lon. 117° 29′ W.

Sun set 5*h*. 0*m*.

Stronger Light, { 6*h*. 30*m*., &c., to 8 45 } Diffuse, 6*h*. 30*m*. and 7*h*. 30*m*.

Sky very fine for observations. At 6ʰ 30ᵐ the Zodiacal Light quite bright, but with no apparent pulsations, though I watched carefully to see whether there were any. At 7ʰ 30ᵐ took boundaries again, marked *b b*, and then thought, but not confidently, that there were such changes. I made the following record:

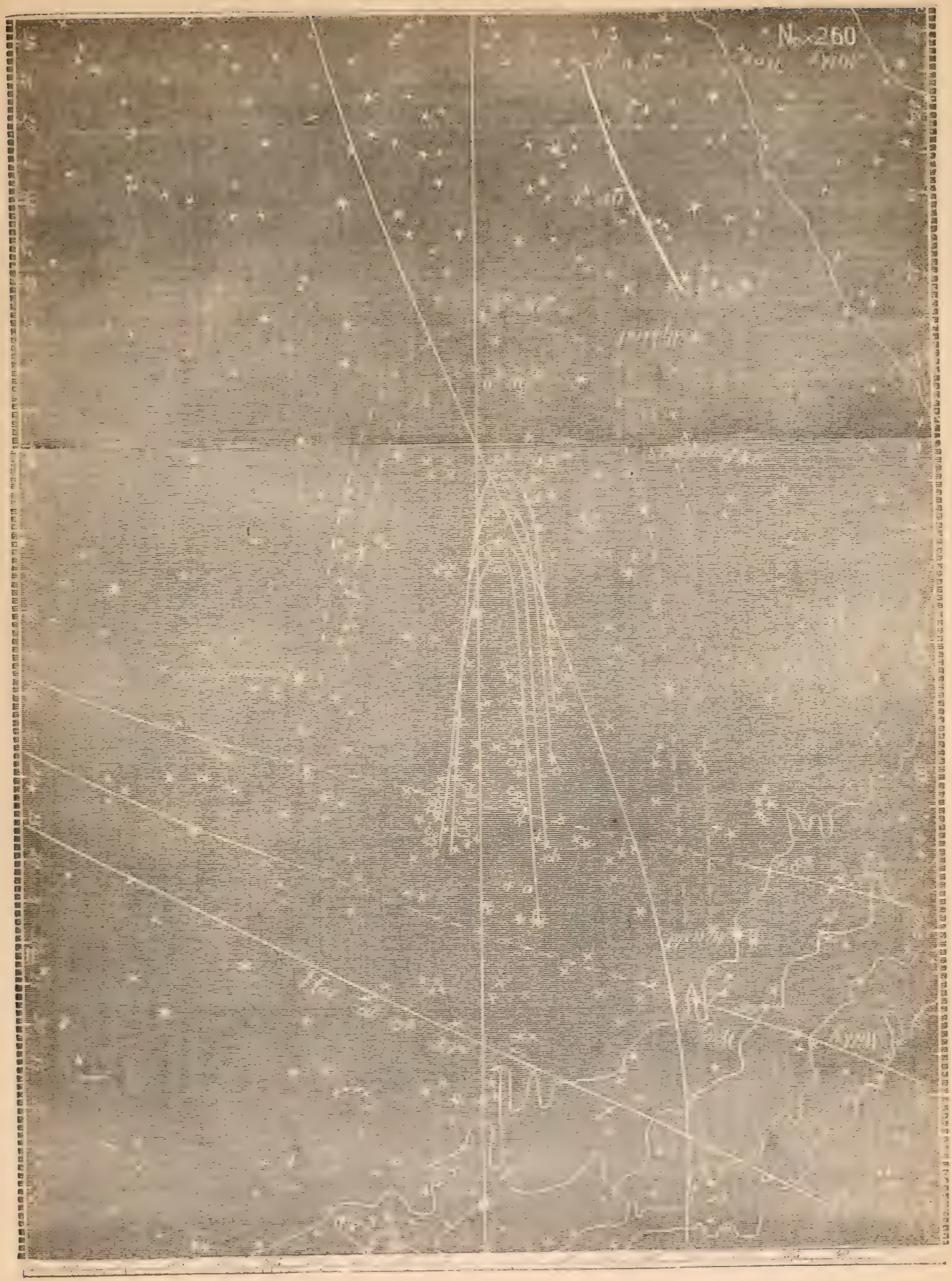
h. *m*.
At 7 31, at *a*, and dim.
7 32, brightening.
7 33½, tolerably bright, and at *b*.
7 34½ bright.
7 38, no change.
7 38½, very bright.
* * *, dimmed apparently?

h. *m*.
At 7 42, very bright.
7 44, dimmed somewhat.
7 45, bright.
7 46, very bright.
7 48, at *c*.
7 54, seems to be permanent in brightness, and at *c*.

The asterisks mean an interval when no particular record was made.

I give this, however, with hesitation; for the changes, if there were such, were very slight; and I often suspected that what I took to be such, are only the consequence of very intense watching and the imagination, or a change in looking from the darkened part of the sky back to the Zodiacal Light. At other times I was more certain.

At 8ʰ 45ᵐ the Light was at *d*; was dim, but still very distinct and well marked. The sky very clear and brilliant this evening.


N. ×260

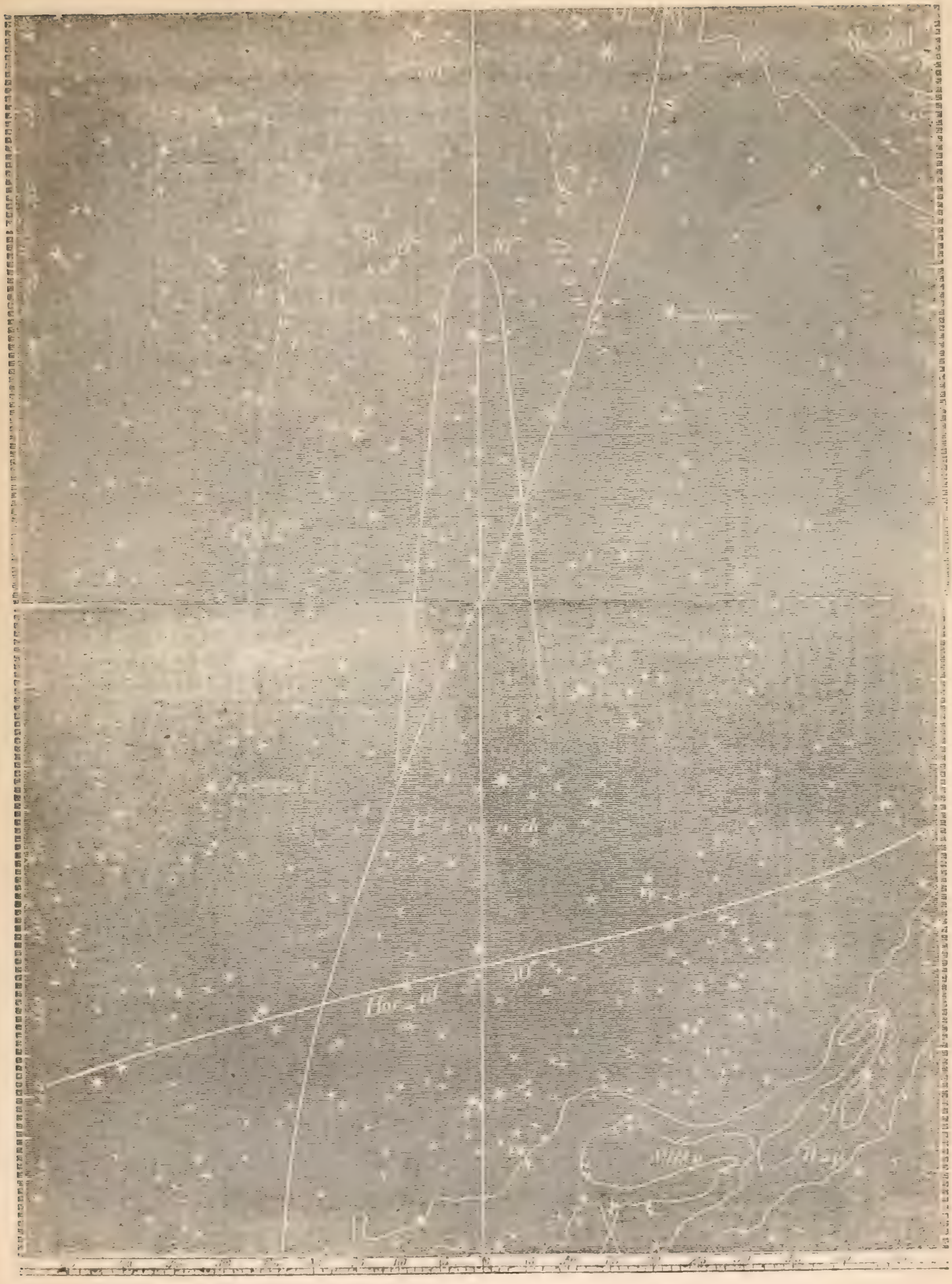
No. 261.

DECEMBER 20th, 1854: Morning.

Lat. at $3^h.\ 30^m.$, 28° 59′ N.: Lon. 116° 43′ W.
Sun rose $6^h.\ 54^m.$
Stronger and Diffuse Light, $3^h.\ 30^m.$
Sun's lon. 268° 20′.

Worn out by the watchings of the previous nights, I did not have myself waked this a. m. till $3^h\ 30^m$, when I found the sky not favorable for observations; but I was able to get outlines, as in the chart. Clouds prevented my getting the lower boundary of the Diffuse Light.

At 5^h was out again, but the sky was now so dimmed by clouds that I could get no reliable boundaries.



No. 262.

DECEMBER 20th, 1854: Evening.

Lat. at 8*h*., 26° 51′ N.: Lon. 115° 27′ W.

Sun set at 5*h*. 7*m*.

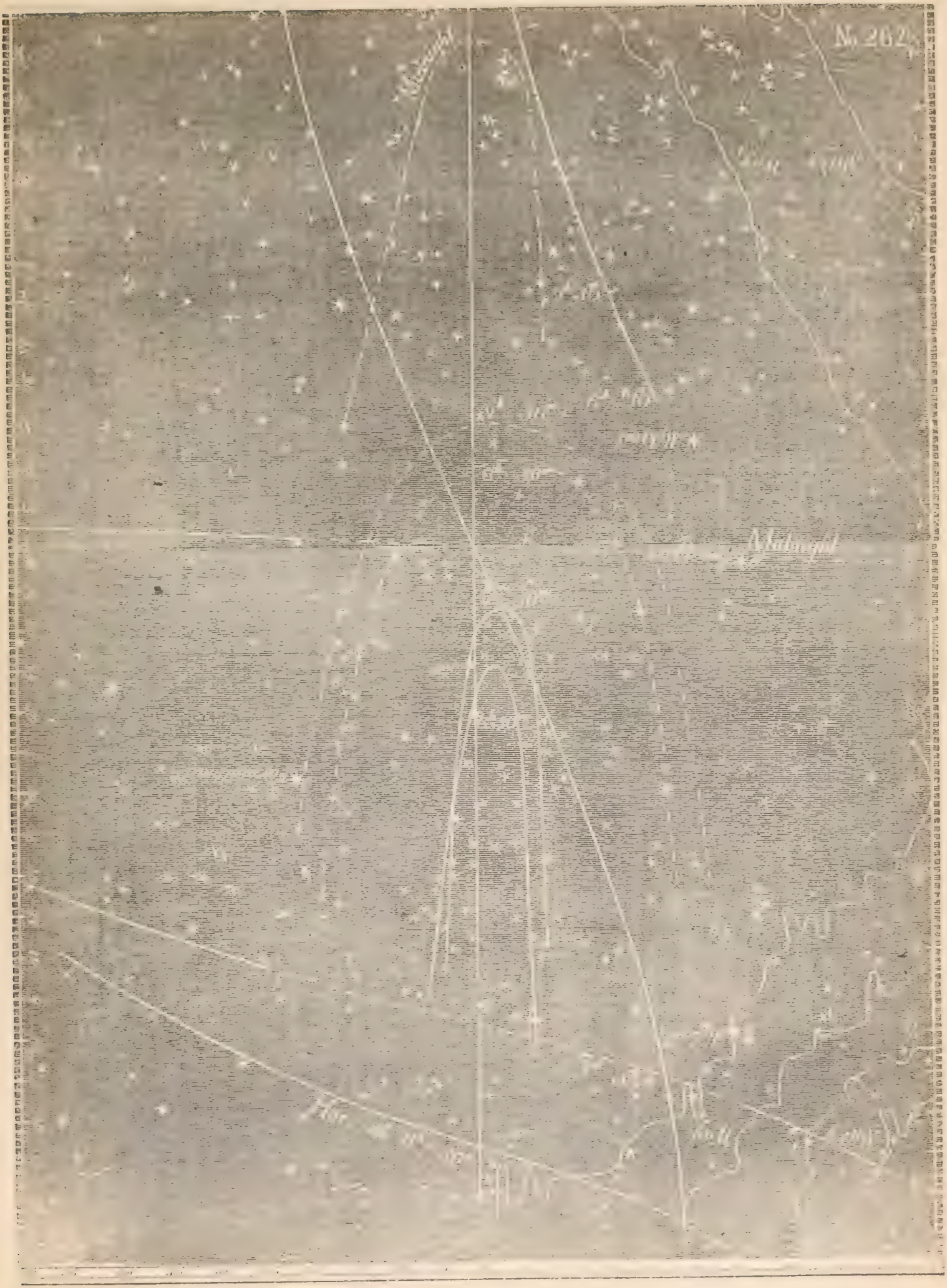
Stronger Light at { 6*h*. 30*m*. / 7 30 / and midnight. } Diffuse, 6*h*. 30*m*. and 7*h*. 30*m*.

Sun's lon. 268° 20′: Zenith point at midnight, Lat. 4° 45′ N.: Lon. 89°.

At 6^h 30^m the Zodiacal Light was very strong, but I could see no pulsations, though the night was favorable for observations. Watched from 7^h 20^m to 7^h 45^m for pulsations, and thought, at times, that there were such changes; but all was so uncertain, that I feel unwilling to make further records of them. At 7^h 45^m the Light was still bright and strong. Went out again at 9 o'clock, but found the sky all clouded over.

Was on deck again at midnight, and found the Zodiacal Light simultaneously in the E. and W. In both directions I thought it was very decided, though faint; the eye easily discovered and recognized it. I have given its boundaries in the chart. At 12^h 45^m this western Light was still distinct.

(For both eastern and western Light, see morning chart—21st.)


No. 262.
Markab
Algenib

No. 263.

DECEMBER 21st, 1854: Morning.

Lat. at 4^h, 25° 5′ N.: Lon. 114° 48′ W.

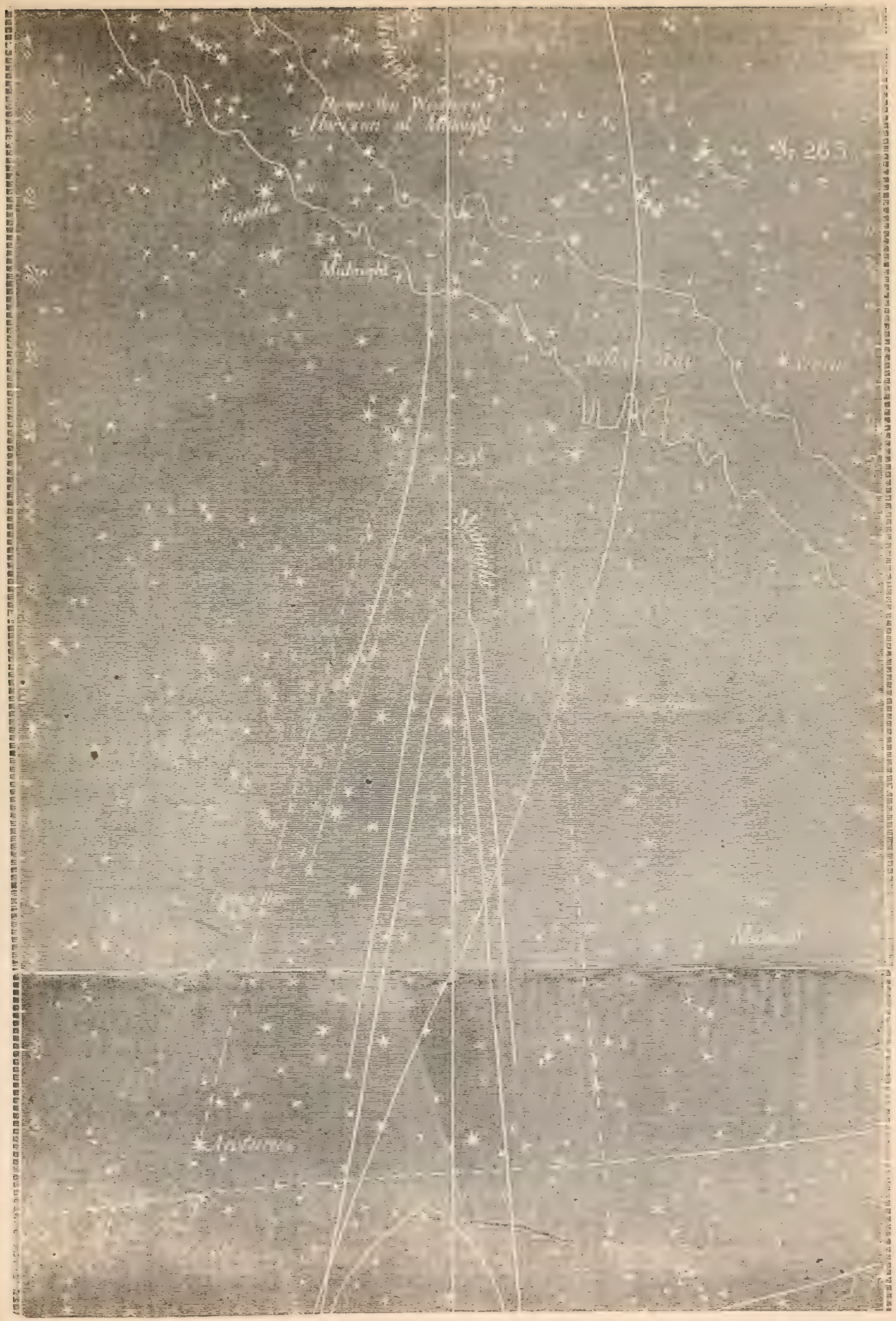
Sun rose at $6^h.\ 47^m.$

Stronger Light at { midnight. / $2^h.\ 0^m.$ / 4 0 } Diffuse at 4 o'clock.

Sun's lon. 269° 21′.

Was on deck at midnight, and found the Zodiacal Light over both west and east horizons distinct, and easily made out at that hour. At that hour the ecliptic is now nearly perpendicular to the horizon. The sky at 12^h was favorable for observations; but at 2^h I had to contend with passing clouds, between which, however, I succeeded in getting reliable boundaries. The same cause interfered at $3^h\ 30^m$, and I was not successful in getting the full out lines till 4 o'clock. On deck again at 5^h, but found the sky so obscured by clouds, that no reliable results could be procured.

Clouds prevented my bounding the Diffuse Light till 4^h. I noticed that the effulgent Light, marked by the zigzag, began to show itself about 4 o'clock.

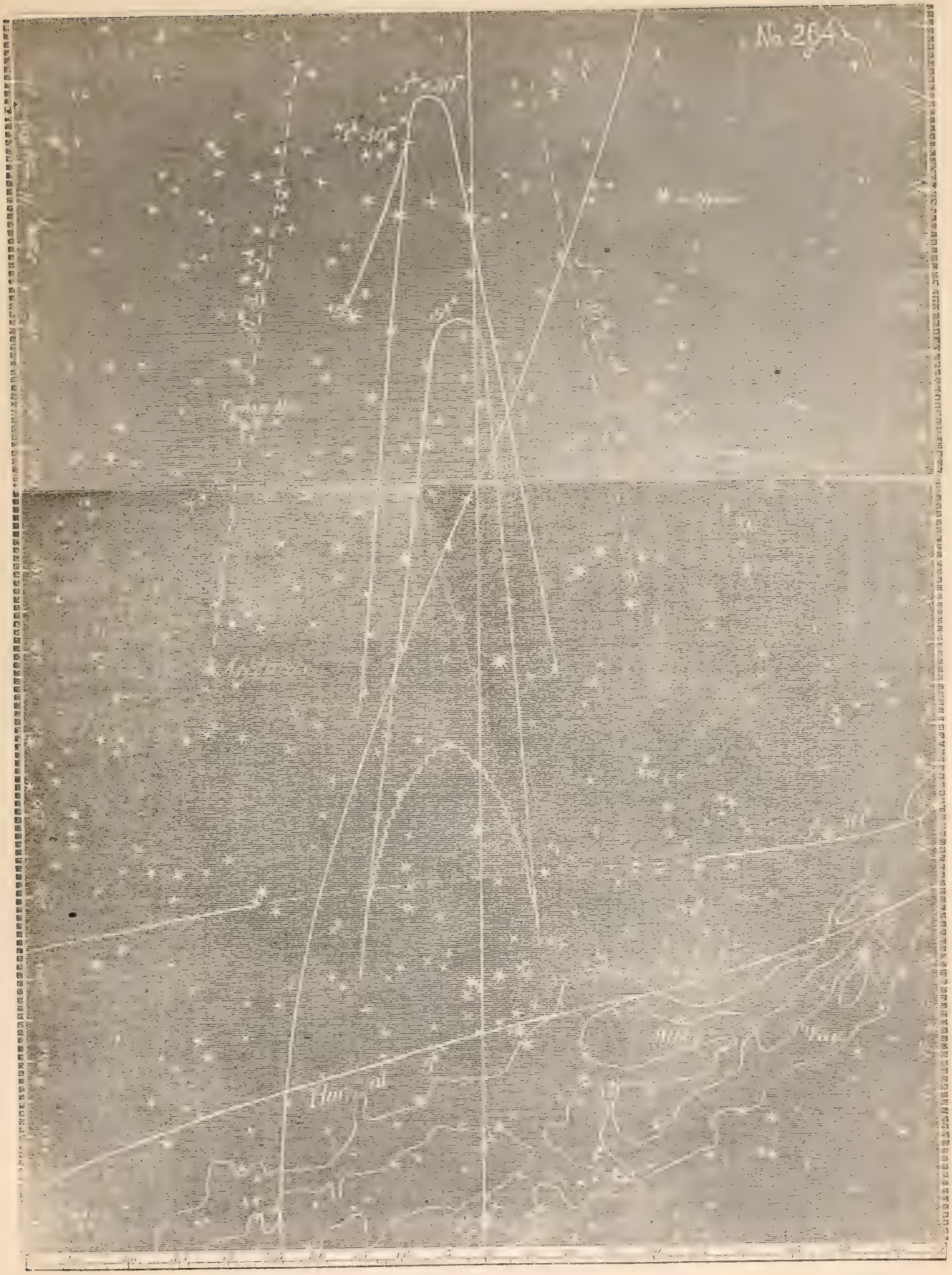

Pegasus
Midnight
Aquarius

No. 264.

DECEMBER 22d, 1854: Morning.

Lat. at 4*h*., 23° 16′ N.: Lon. 112° 20′ W.
Sun rose at 6*h*. 41*m*.
Stronger and Diffuse Light at 3*h*. 30*m*. and 5*h*.

Clouds prevented observations last evening. The morning sky was very clear and brilliant, and I had good observations. But the Diffuse Light is now so strong, and the Stronger Light melts so gradually into it, that it is very difficult to get boundaries for the latter. At the first observation this a. m., I spent half an hour in verifying my boundaries; and I believe those given may be relied on. Both then and at 5^h I was particularly careful in my observations. At 5^h the effulgent Light within the zigzag lines was very brilliant. Watched to see whether there were pulsations, but could not discover any. Could not get the upper end of Diffuse Light.

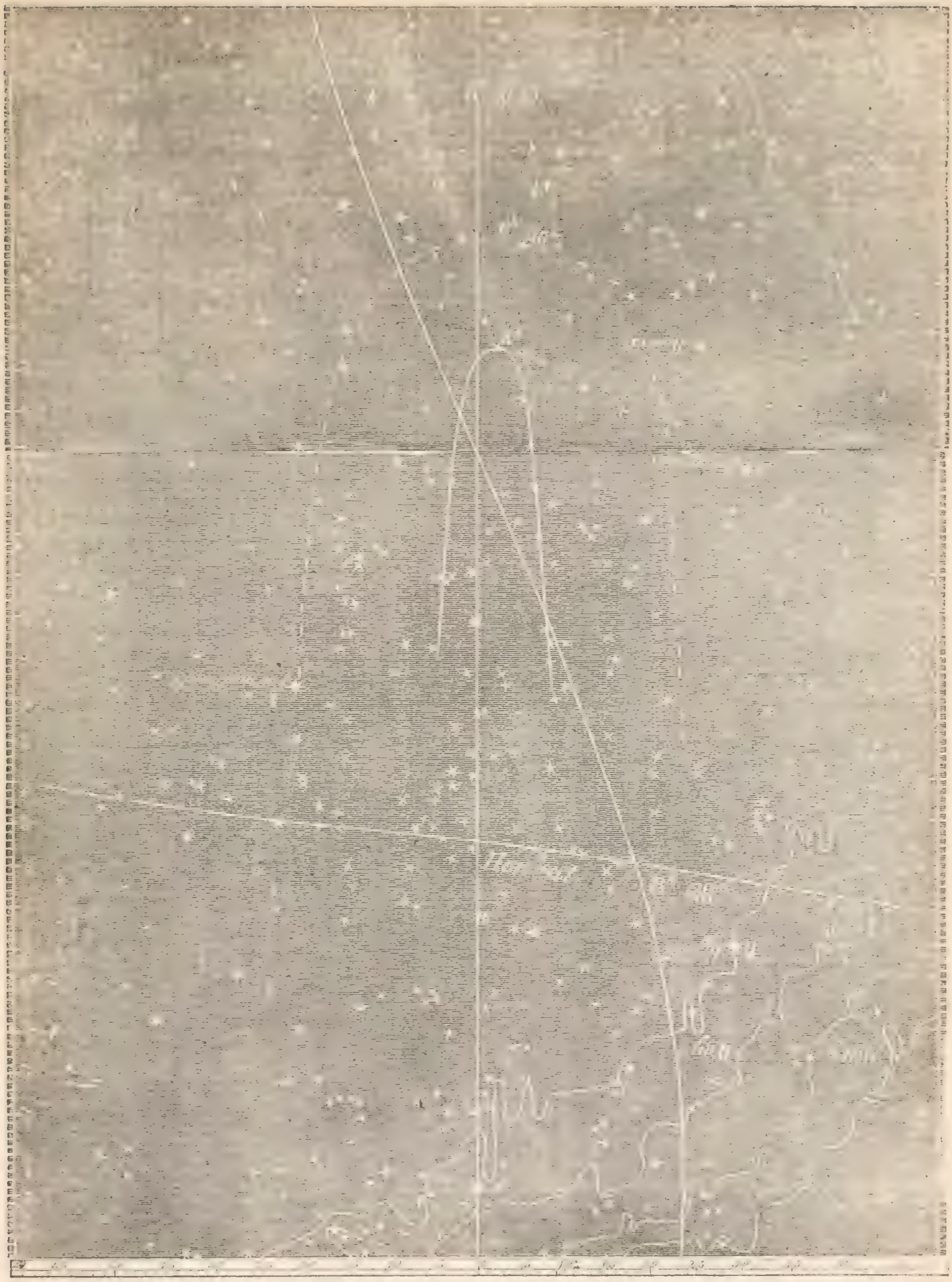

No 264

No. 265.

DECEMBER 22d, 1854: EVENING.

Lat. at 8*h*., 21° 49′ N.: Lon. 110° 39′ W.
Sun set at 5*h*. 20*m*.
Stronger and Diffuse Light at 8*h*. 30*m*.

The moon did not set till about 8ʰ 30ᵐ, at which hour I was able to get an observation. The Zodiacal Light was still distinct, though dim, and gave boundaries which I think may be considered reliable. I was on deck again at midnight, in order to get east and west simultaneous observations; but there was such a haziness over the horizon as to defeat all such efforts.



No. 266.

DECEMBER 25th, 1854: MORNING.

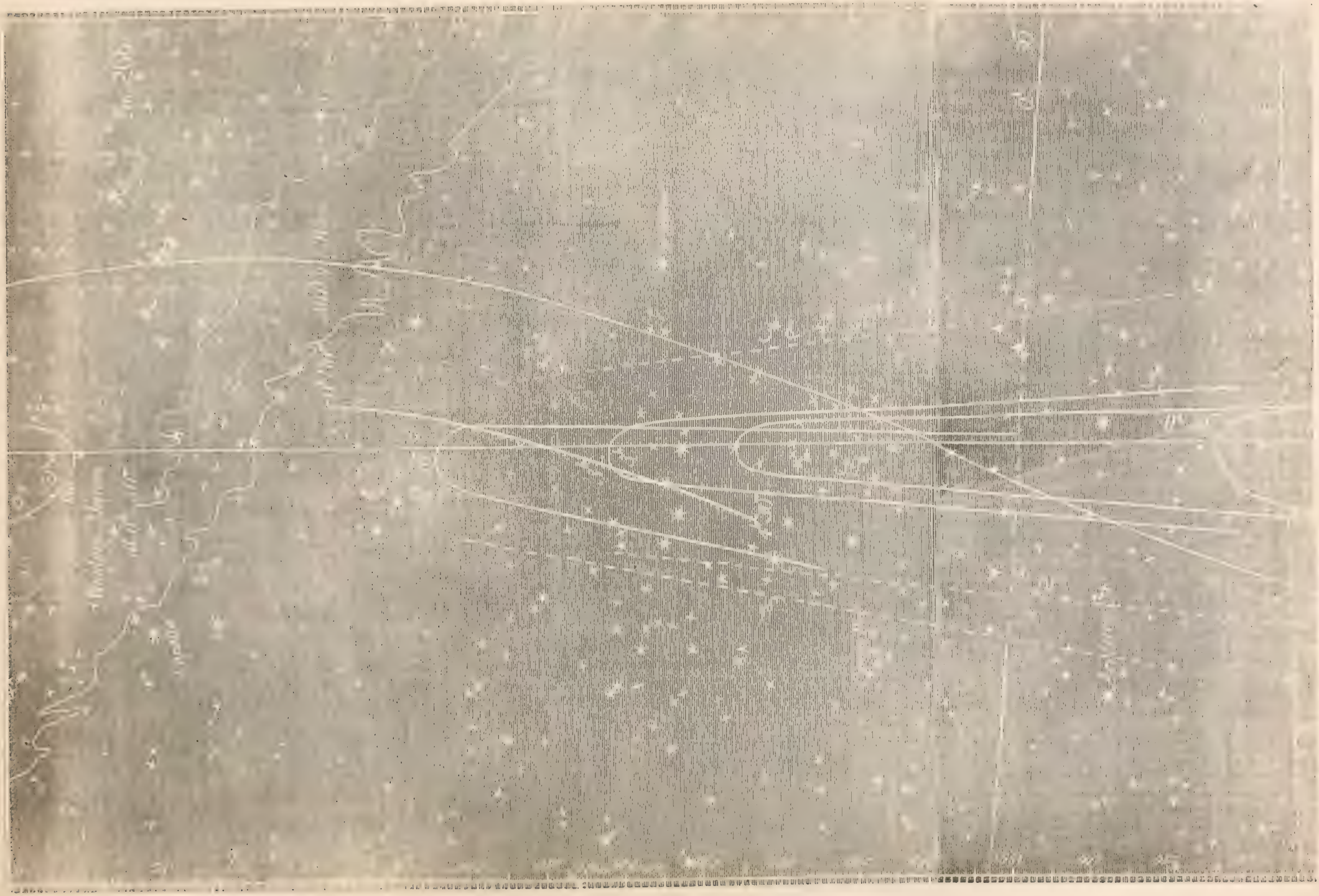
Lat. at 4*h*., 17° 21′ N.: Lon. 163° 17′ W.

Sun rose at 6*h*. 32*m*.

Stronger Light at { 12*h*. 30*m*. / 3 0 / 4 30 } Diffuse at 3*h*. and 4*h*. 30*m*.

Sun's lon. 273° 26′.

Cloudy the last two mornings. I was on deck at 12 o'clock to-night, but was baffled by passing clouds till 12^{h} 30^{m}. The sky then was free from clouds, but was not at its brightest; yet I thought there could be no doubt of the Zodiacal Light, at that hour, at both western and eastern horizons. The western gave me boundaries more easily than the eastern, where I had some difficulty in getting them satisfactorily. At 3^{h} the sky was brilliant, and the Zodiacal Light very bright; but there was the same difficulty, as on the 22d, in getting boundaries of the Stronger Light, and from the same cause. At 4^{h} 30^{m} the Light was remarkably strong; strongest within the zigzag lines. Dawn towards 5 o'clock.



No. 267.

DECEMBER 25th, 1854: Evening.

Lat. at 7*h.*, 16° 31′ N.: Lon. 101° 25′ W.
Sun set at 5*h.* 30*m.*
Joint sun and moon at 6*h.* 50*m.*: Stronger Light at midnight.
Sun's lon. 273° 26′.

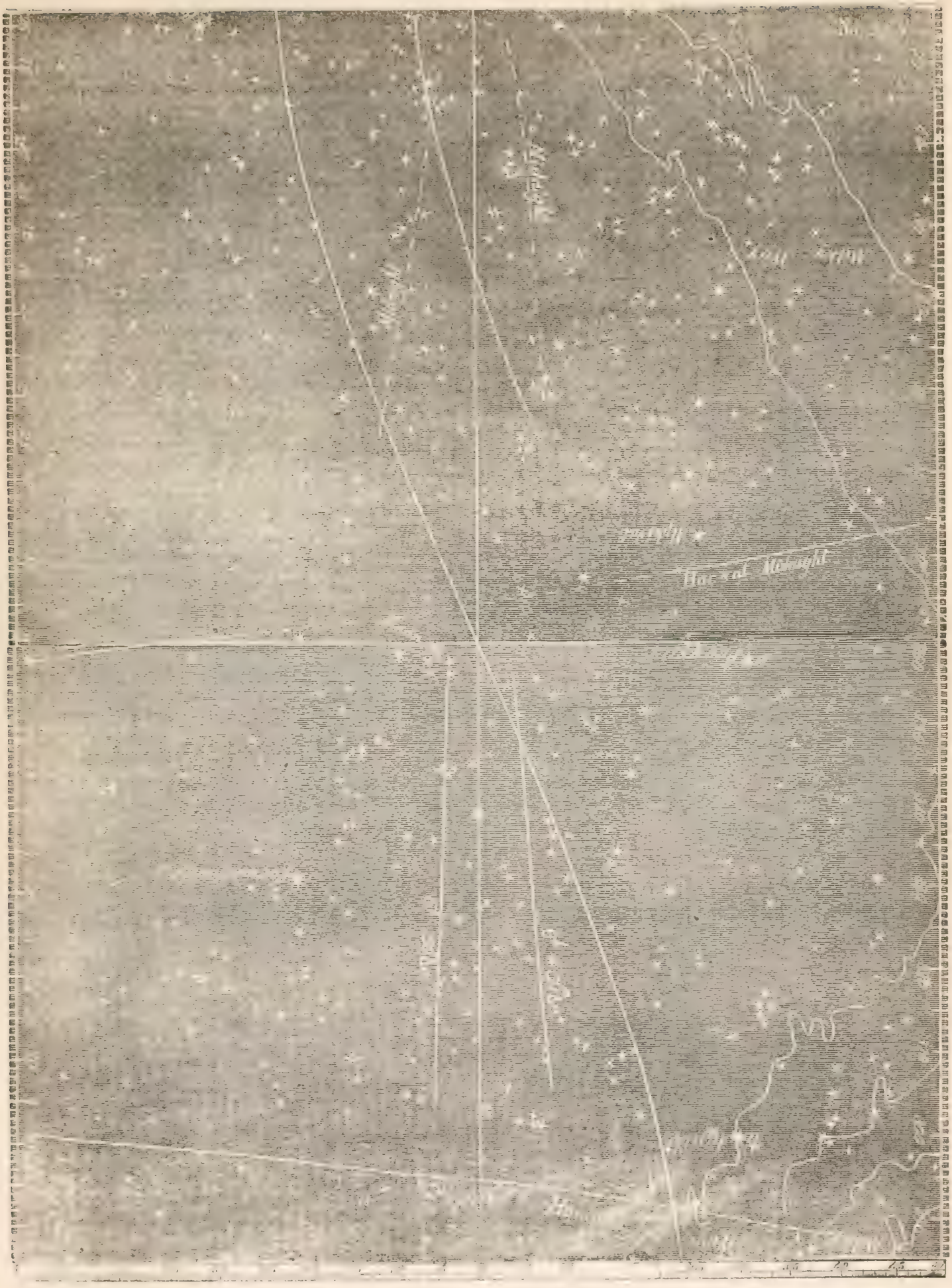
Joint Sun and Moon Zodiacal Light, &c.—I have been on the watch, ever since my observation of March 6th, for a joint sun and moon Zodiacal Light, but have not been successful until this evening, when the moon being in the right position, and the sky remarkably clear and bright—clear down to the very horizon—I had a successful and a remarkably interesting observation. Going on deck as soon as the evening had sufficiently advanced—*i. e.*, at $6^h\ 50^m$—I found the sky decidedly marked by a bright streak within the usual bounds of the Zodiacal Light. This had not the ordinary warm coloring of the Zodiacal Light; but was more like a dim silvery moonlight; but of the greater brightness itself, within these boundaries, there could be no doubt. I sent for Dr. ——, and asked him to tell me whether he saw any particular brightness in that part of the sky; which he did at once, giving it the boundaries that I have given in the chart, except that he did not carry it so far up. Captain Lee and acting Lieutenant K——, then on the poop-deck, also made it out without any difficulty. This observation is the more interesting and remarkable from the fact that the Light, although deriving its strength, in a great degree, from the moon (to such a degree as to make it surpass the surrounding moonlight itself), did not stretch up exactly in the direction of the moon, but kept within the Zodiacal Light bounds, while the moon itself was quite outside of these. See the position of the moon in the chart. This Light continued till $7^h\ 48^m$ as striking as at the first sight of it at $6^h\ 50^m$. At 8^h it was not so strongly marked; at that hour, however, it appeared to stretch up beyond the moon; but of this last I am not certain.

The night being so fine for observations, I determined to have observations of the simultaneous east and west Zodiacal Light as early and as late as it would exhibit itself; to be made with particular care. The moon, however, did not set till $11^h\ 36^m$, and its effulgence in the western sky continued for some time after. Immediately on its setting, the *eastern* Zodiacal Light became manifest, quite decidedly showing itself; but its right-hand or southern boundary was so uncertain, that I cannot give the one in the chart as fully reliable. The *western* Zodiacal Light, when the moonlight was fully gone, showed itself also, I thought decidedly, and I got its boundaries without difficulty. But neither in the east nor west was this Zodiacal Light so satisfactory or strong as on previous recent occasions. The horizon, at midnight, has now changed considerably, owing to our rapid progress to the south, and the ecliptic and it are no longer perpendicular, as before.

At 1 o'clock, in the west, there was nothing reliable. In the east, the Light had strengthened; but I had the same difficulties about its boundaries as before.

(The direction of this Light, at the observation of $7^h\ 50^m$, may show that the moon exercised no sensible attraction in the substance producing it.)

P. S. *December 26, Evening.*—I looked this evening to see whether there might be a similar Zodiacal Light; but there was none. The moon had doubtless got beyond the proper position for such a result.



No. 268.

DECEMBER 26th, 1854: MORNING.

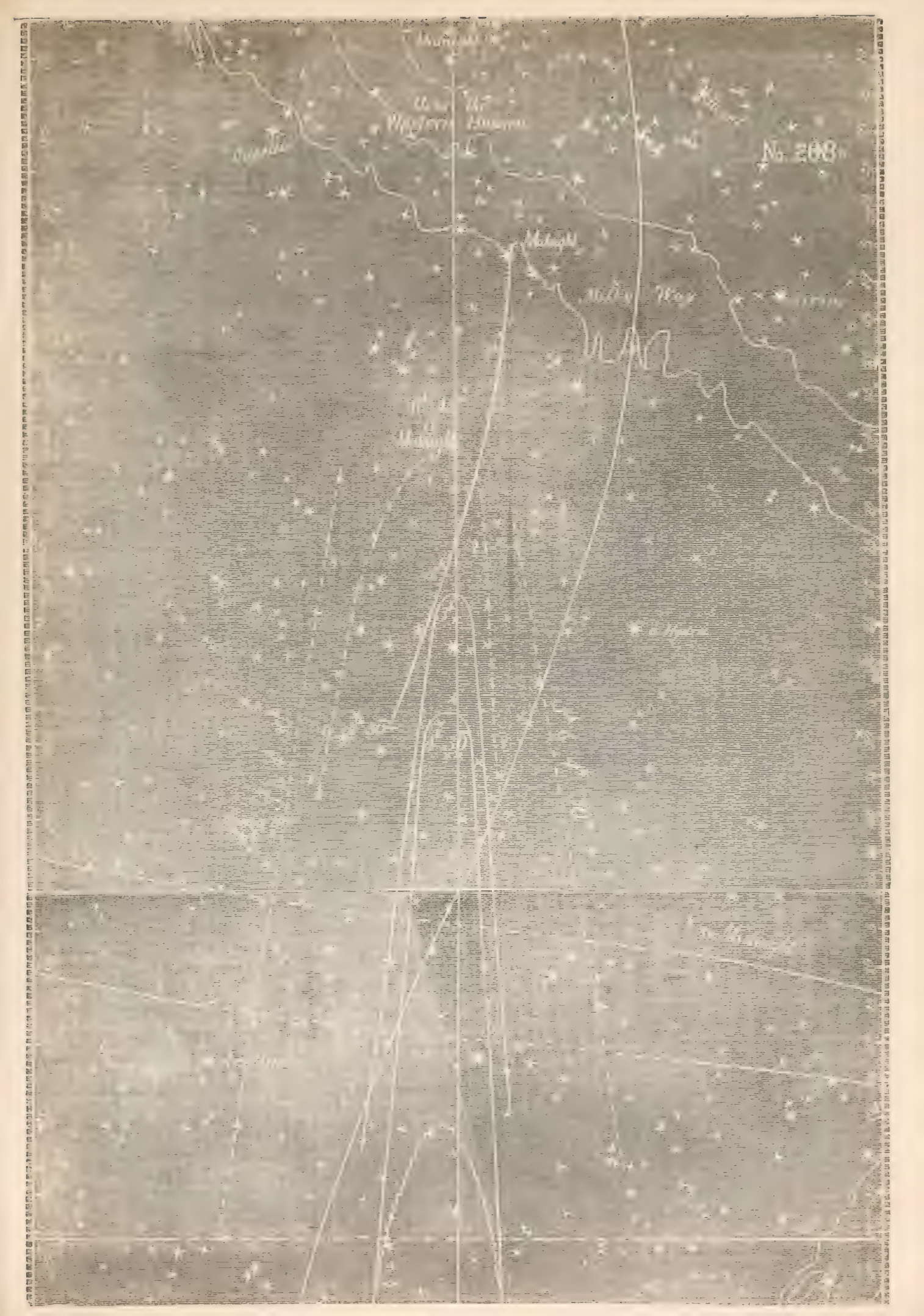
Lat. at 4*h*., 15° 59′ N.: Lon. 100° 24′ W.

Sun rose at 6*h*. 30*m*.

Stronger Light at { 11*h*. 45*m*. of 25th. / Midnight. / 3*h*. 0*m*. / 4 30 } Diffuse 3*h*. 0*m*. and 4*h*. 30*m*.

Sun's lon. 274° 27′.

For a notice of a simultaneous east and west Zodiacal Light on this occasion, see evening record of the 25th. As there stated, I found, when the moon set at 11^h 36^m, the eastern Zodiacal Light decidedly marked on the sky; its northern boundary easily made out, but the southern one not to be procured so as to be fully reliable; but I have done the best I could. Wishing to make certainty more certain, that this *was* the Zodiacal Light, I watched it till 12^h 30^m, and was again on deck at 1 o'clock. At the latter hour it had increased in brightness, and had seemingly the same boundaries as at 11^h 45^m and at midnight; but it presented the same difficulties about the southern boundary. A good exhibition of this simultaneous east and west Light seems to require that the ecliptic should be at right angles with the horizon on both sides. That was the case a few nights ago; but our rapid movement southward has changed the angle considerably: and, to-night, I did not find the midnight Zodiacal Light as bright or well defined as on those recent occasions. I was glad, however, to have the observation, as the sky was remarkably favorable, and, owing to the increase of the moon, I can expect no more such for some time. At 3^h and 4^h 30^m, the Light was remarkably bright: brightest at 4^h 30^m, below the zigzag.

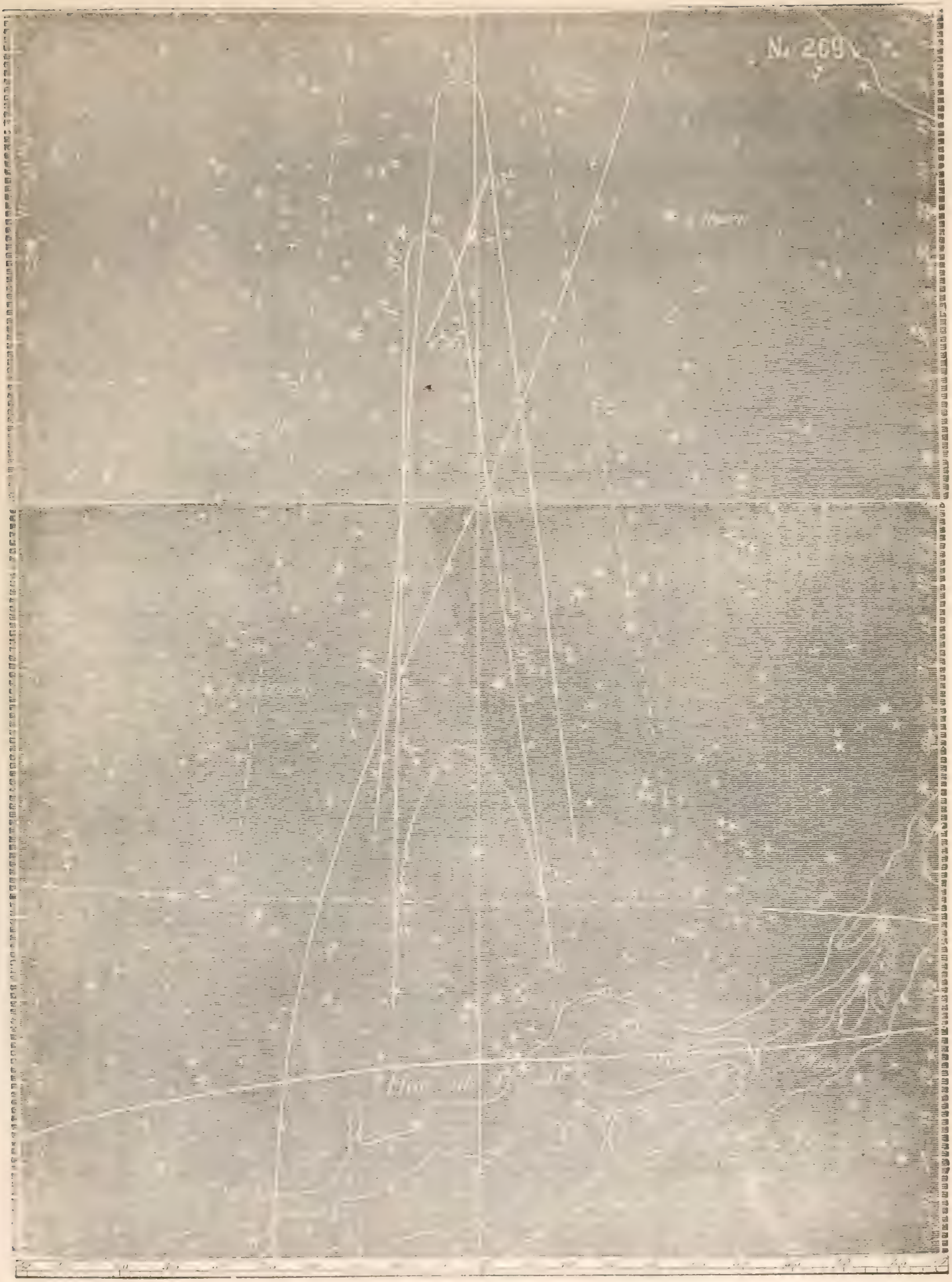

No. 208
Midnight
Milky Way

No. 269.

DECEMBER 28th, 1854: Morning.

Lat. at 4*h*., 13° 18′ N.: Lon. 94° 44′ W.
Sun rose at 6*h*. 25*m*.
Stronger Light at 3*h*. 0*m*. and 4*h*. 30*m*.: Diffuse at 3 o'clock.
Sun's lon. 276° 29′.

Clouds yesterday morning. Sky this a. m., at 3 o'clock, very clear and bright; at 4^h 30^m was troubled by passing clouds, but still, by careful watching, I was able to get reliable boundaries for the Stronger Light: could not succeed for the Diffuse at that hour. The remarkable sliding over of the upper part of the Stronger Light, which may be seen in all my recent observations, was so great this morning, that I could not be satisfied about it until after repeated trials, all bringing the same result. I believe that the boundaries on the chart may be considered fully reliable, each new effort to trace them, by different stars, having given me the same result. The effulgent Light, very strong at 4^h 30^m, is marked by the zigzag lines. Dawn at 5 o'clock.

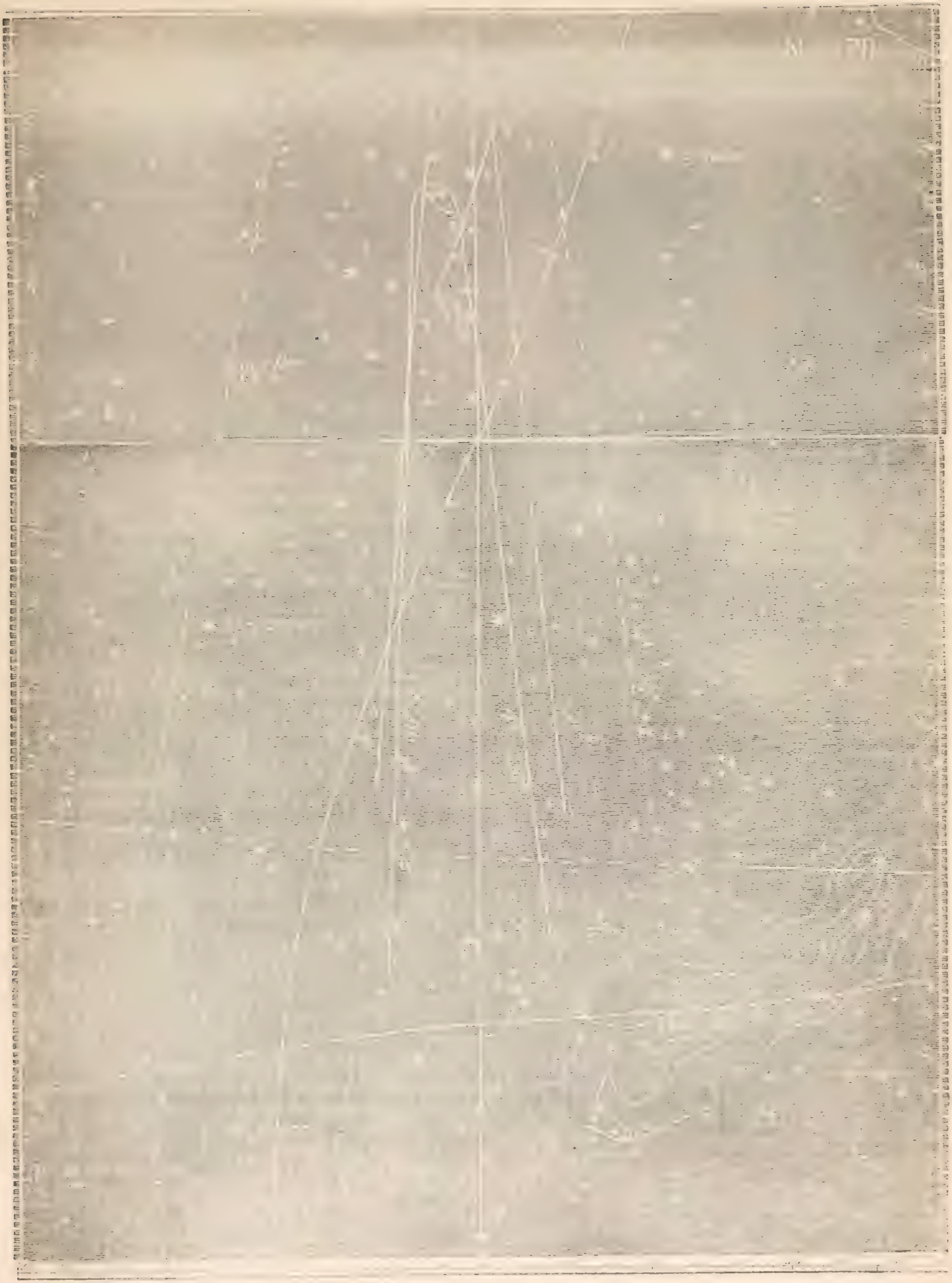

No 209

No. 270.

DECEMBER 29th, 1854: Morning.

Lat. at 4*h*., 11° 38′ N.: Lon. 92° 3′ W.
Sun rose at 6*h*. 22*m*.
Stronger and Diffuse Light at 3¼. and 4*h*. 30*m*.

Sky remarkably favorable for observations, both at 3ʰ and at 4ʰ 30ᵐ. Took great pains to get the boundaries correctly, and I believe those given may be relied on, though they are not very strongly marked at their upper end; and I had to make frequent trials before I could satisfy myself of my correctness. The upper end of the Diffuse Light is so indistinct that I now make no effort at getting it.



No. 271.

DECEMBER 30th, 1854: MORNING.

Lat. at 4^h., 19° 46′ N.: Lon. 89° 31′ W.
Sun rose at 6^h. 22^m.
Stronger Light at 4^h. 15^m: Diffuse at 4^h. 20^m.

The sky was cloudy at 3^h; but by 4 o'clock it had cleared off again, and was very favorable for observations. I was again particularly exact in getting boundaries, on account of the great change which has occurred in the angle between the axis of the Zodiacal Light and the ecliptic. It will be observed from the chart, that the latter, in this latitude, and at this time, is nearly at right angles with the horizon. I also, this morning, gave attention to the stars as seen through the Zodiacal Light, and found, even to 4^h 30^m, when the effulgent Light below the zigzag lines is very strong, that with the naked eye I could readily make out stars of the 6th magnitude within the effulgent Light; for instance, the group of stars just south of 38 Libræ (shown by dots at *a* on the chart), and also a single star of 6th magnitude between 38 and 48, and 49 of do. (see dots at *b* on the chart); also a line of four stars below 19 Libræ, and ranging with β Libræ (see dots at *c* on the chart); the two northernmost of these last are of the 7th magnitude, yet I think the naked eye detected them, even within this effulgent Light; but the last are near its upper edge. All this shows the great transparency of the substance giving the Zodiacal Light. At 4^h 41^m, this effulgent part, which hitherto had been a warm light of great brightness, almost suddenly became a cold whitish light, at the same time sinking down and spreading at its base on either side. At 4^h 46^m dawn fully showed itself.

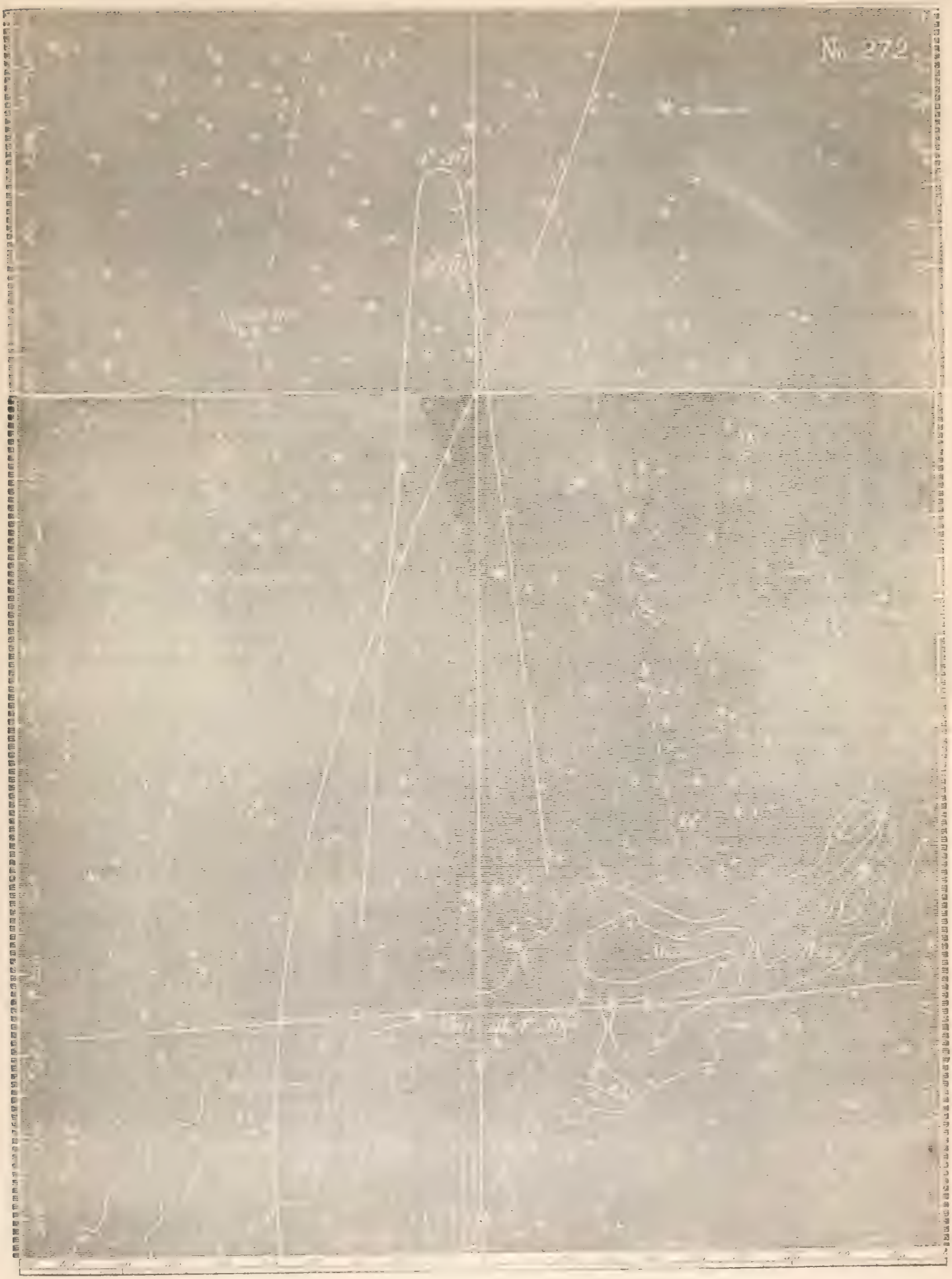
No 271

No. 272.

JANUARY 1st, 1855 (Monday): MORNING.

Lat. at 4*h*. 30*m*., 7° 27′ N.: Lon. 85° 30′ W.
Sun rose at 6*h*. 17*m*.
Stronger and Diffuse Light at 4*h*. 30*m*.

The moon did not set till near $4^h\ 30^m$. Went on deck at that hour, and found the sky very bright and favorable for observations. Had not much difficulty in getting boundaries, but was still very careful and exact about them. Afterwards watched the dawnlight, as it commenced at the horizon and crept rapidly upward. At $4^h\ 39^m$ it may be said to have fairly shown itself in the sky.

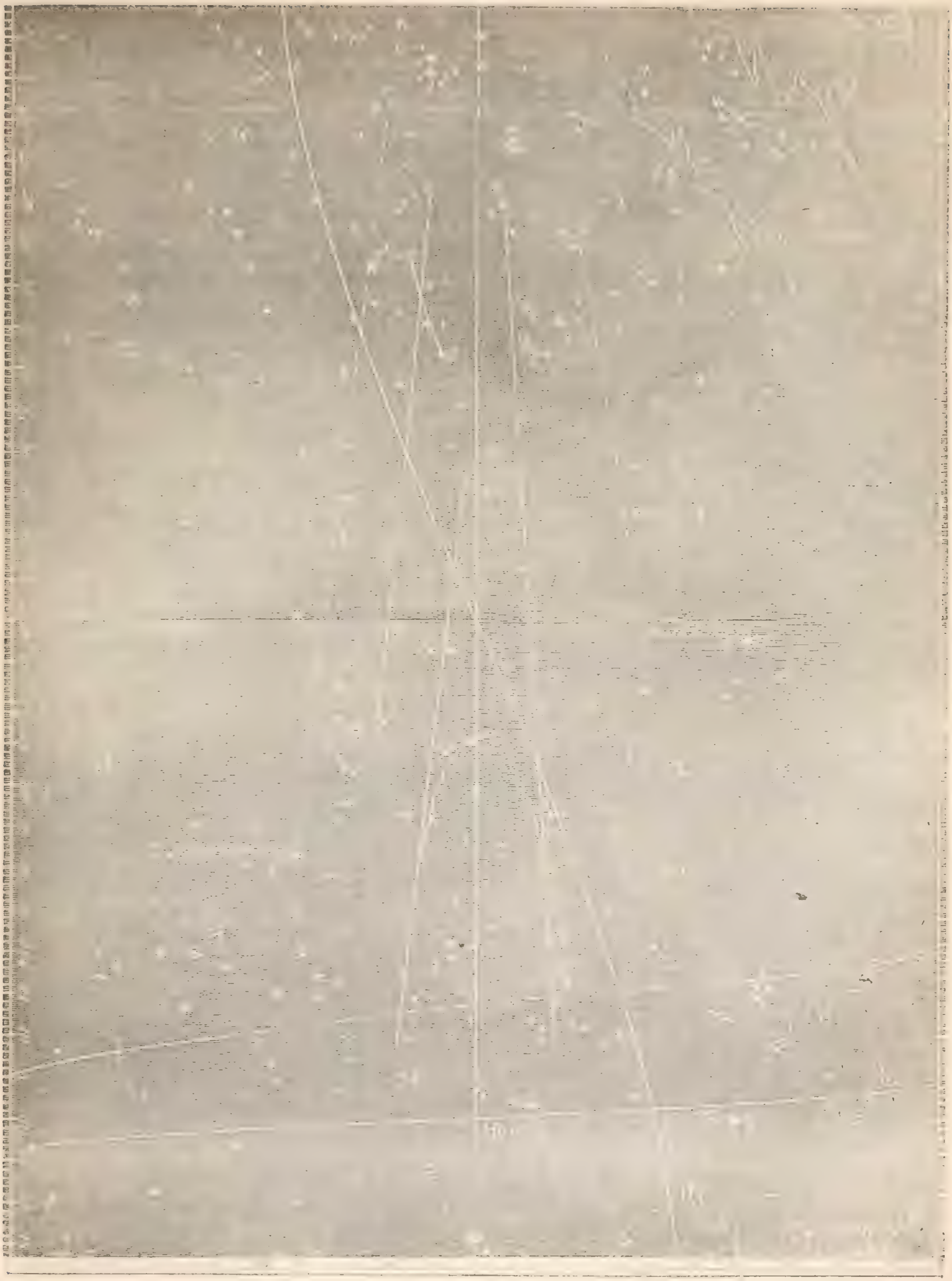

No. 272.

No 273.

JANUARY 5th, 1855: Evening.

Lat. 8° 47′ N.: Lon. 79° 31′ W.
Sun set at $5^h.\ 51\frac{1}{2}^m.$
Stronger Light at $7^h.$ and $7^h.\ 50^m.$: Diffuse at 7 o'clock.

Moon, and clouds also, since my last, both morning and evening. This evening the western sky was clear and favorable for observations. The Zodiacal Light was quite distinct at $6^h\ 50^m$, but did not give fully reliable boundaries till 7 o'clock. At $7^h\ 50^m$ there was a singular appearance within the boundaries marked for that time. It was as if a thin white gauze had been drawn along the sky, quite concealing the smaller stars, and yet in all other respects like the Zodiacal Light. I thought, at first, it was a thin cloud or haziness, and watched to see it change; but it was permanent, and, except its hiding the stars, was so much more like the usual Zodiacal Light, that at last I recorded it as such. The Light at 7^h was very strong, with a more effulgent portion below the zigzag line. Moon rose about 8 o'clock.

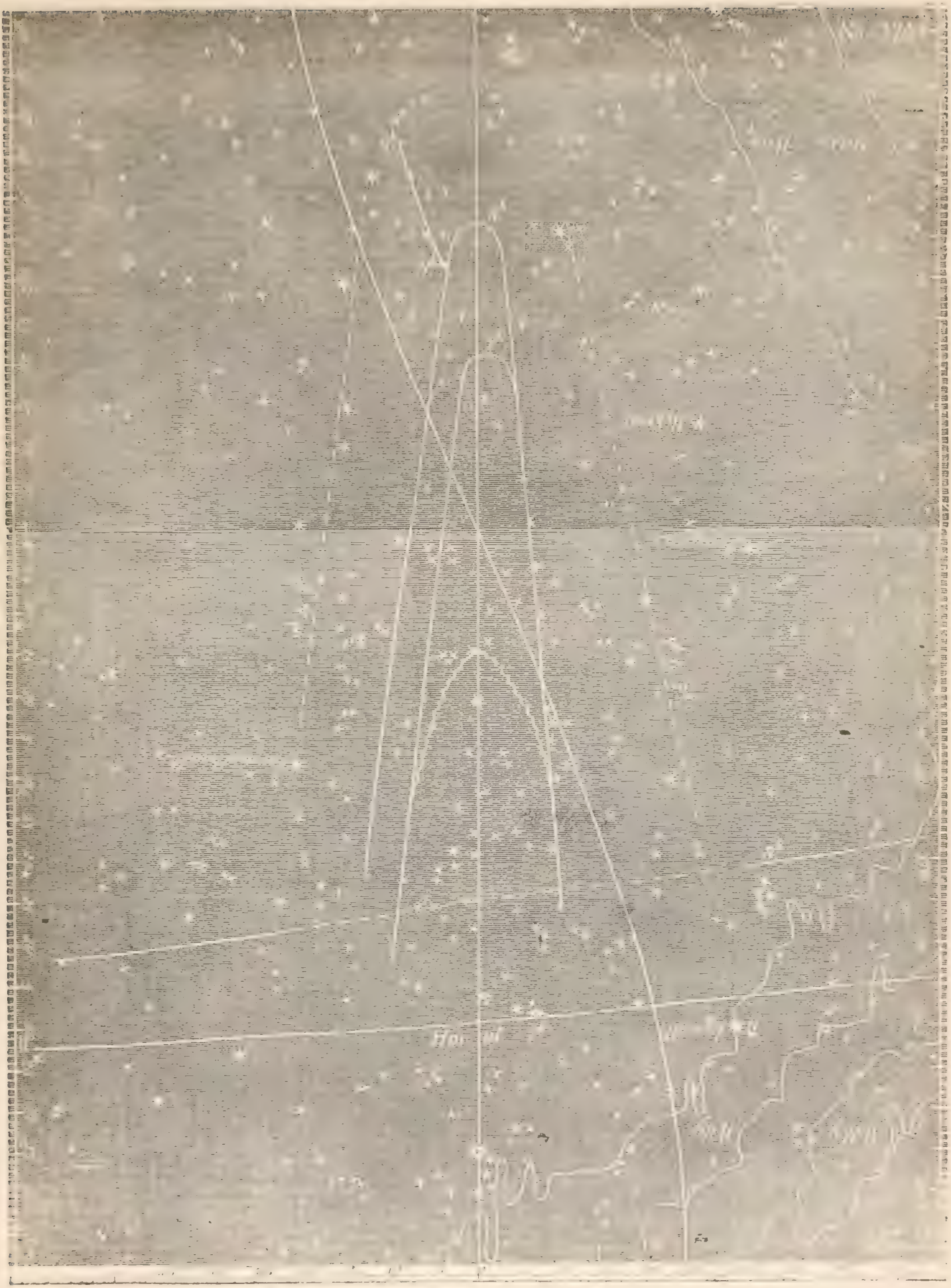


No. 274.

JANUARY 6th, 1855: Evening.

Lat. 8° 47′ N: Lon. 79° 31′ W.
Sun set at $5^h.\ 51\frac{1}{2}^m$.
Stronger and Diffuse Light at 7 and 8 o'clock.

Sky favorable, very bright and clear. Zodiacal Light, at 7^h, very brilliant. The effulgent Light within the zigzag lines lasted till $7^h\ 40^m$: at 8^h, a little of it was left, but much dimmed. Looked for pulsations, but could not see any. At 8^h it was difficult to get the southern outline of the Stronger Light. Could not see any of the gauze-like appearance dimming the stars, which was noticed last evening.



No. 275.

JANUARY 8th, 1855: EVENING.

Lat. 8° 47′ N.: Lon. 79° 31′ W.

Sun set at 5*h*. 52*m*.

Stronger Light at { 7*h*. 15*m*. &c., to 8 30 } Diffuse at 7*h*. 15*m*., &c

Sun's lon. 287° 42′.

Yesterday was Sunday. Clouds in west, this evening, till after 7*h*, when the sky cleared off, and became extremely favorable for observations. It will be seen by reference to the chart, that the ecliptic is, at that hour, nearly perpendicular to the horizon. At 7*h* 15*m* the effulgent Light below the zigzag was remarkably bright. I took the boundaries as in the chart, but in fifteen minutes after was surprised to find that already they were considerably extended; and I began to query whether there were not pulsations. At 7*h* 36*m* I was satisfied that there were; for the Light was now back at the first boundary *a a*, and had dimmed considerably. My record from this was as follows:

h. m.

"At 7 39, brightening.

7 42, at *b*, and bright; has brightened most decidedly since 7*h* 39*m*.

* * *

7 50, decidedly dimmed, compared with 7*h* 42*m*.

7 52, has brightened and dimmed again in the last 2 minutes.

h. m.

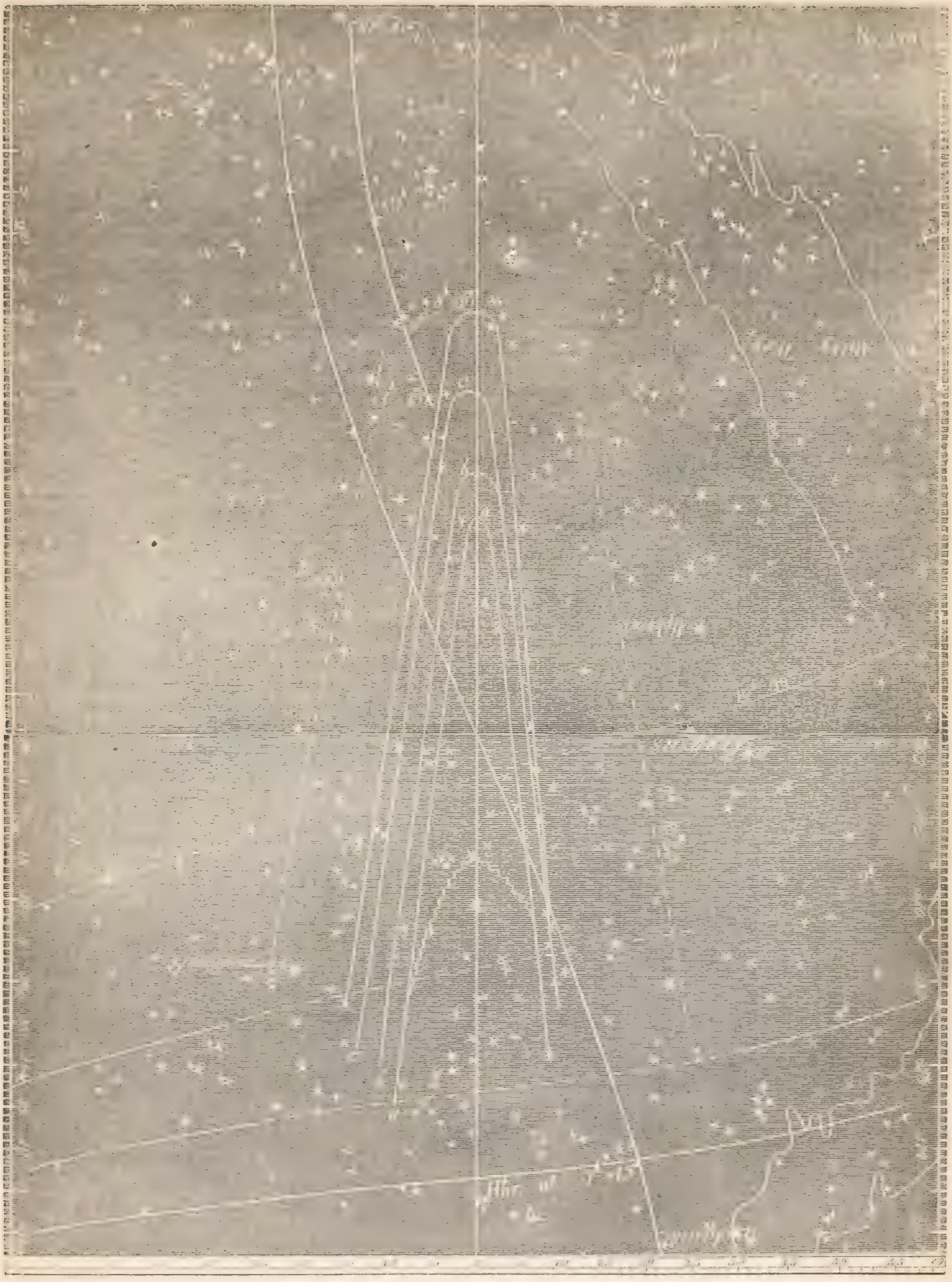
At 7 54, has brightened and dimmed once more since last.

7 55½, bright, and at *b*.

7 58½, still bright.

8 o'clock, still so.

At 8*h* 8*m* still bright, and its boundaries at *c*. A change has come over it in the last eight or ten minutes. It has extended its boundaries to *c c*, and the upper part has become decidedly brighter than at any time before. In the early part of the evening, say at 7*h* 15*m*, the portion below the zigzag was extremely bright; while the upper was dimmed off, till it was very difficult to make out its highest portions. Now, the lower part is not strikingly bright; while the upper portions, as just remarked, have increased in brightness, so that it is easy to trace them. This has been since the pulsations ceased." I neglected to notice when the great effulgence below ceased. At 8*h* 30*m* boundaries still well marked. At 10*h* 30*m*, perhaps a paleness in that part of the sky, but nothing decisive. In noticing these pulsations, I was assisted by one of the petty officers of the ship: he had no difficulty in observing the changes of the brightness.



No. 276.

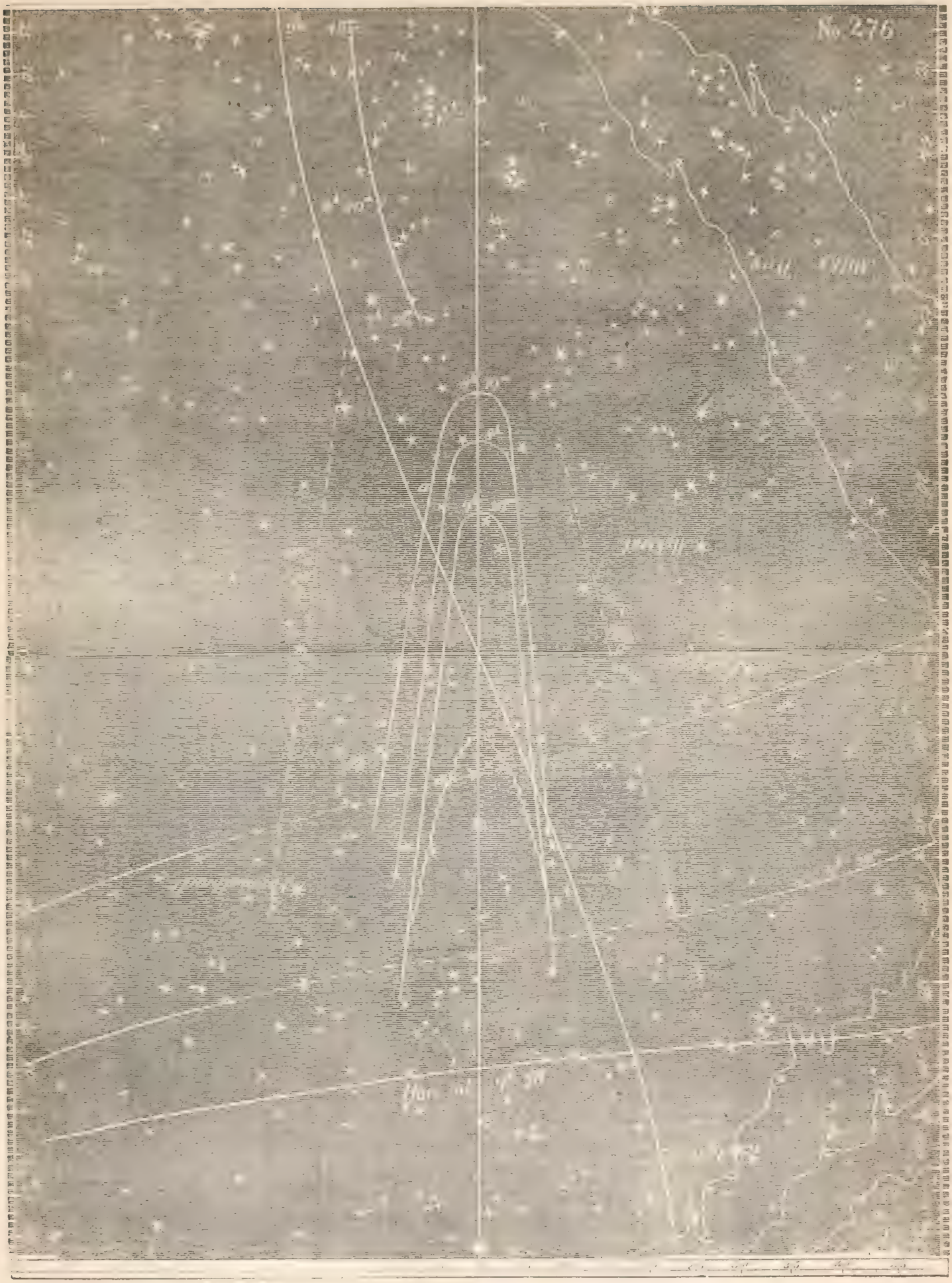
JANUARY 9th, 1855: Evening.

Lat. 8° 47′ N.: Lon. 79° 31′ W.

Sun set at 5*h*. 52*m*.

Stronger Light at { 7*h*. 20*m*. / 8 0 / 8 10 } Diffuse at 7*h*. 20*m*. and 8*h*. 0*m*

Clouds obscured the western sky till $7^h\ 15^m$: I was able, however, to notice that the effulgent Light under the zigzag showed itself first at $7^h\ 13^m$. Got outlines at $7^h\ 20^m$; but clouds still interfering, prevented my having any very satisfactory observations about pulsations, though I could see that there were such. My records say, "$7^h\ 43^m$ exceeding bright: $7^h\ 45^m$ dim: $7^h\ 53^m$ very bright: $7^h\ 55\frac{1}{2}^m$ has dimmed sensibly: $7^h\ 57^m$ brightening: * * * 8 o'clock, now very bright. At $8^h\ 5^m$ the increased brightness at the upper part almost suddenly commenced; the effulgence below the zigzag still continuing, but not as bright as before." At $8^h\ 10^m$ the southern or left-hand boundary seemed to have suddenly extended to *a a*, as in the chart. At $8^h\ 15^m$ the effulgence below the zigzag was gone. At 9^h the Zodiacal Light was still strongly marked, but gave no reliable boundaries; so also at $9^h\ 45^m$.


No. 276

No. 277.

JANUARY 10th, 1855: Evening.

Lat. 8° 47′ N.: Lon. 79° 31′ W.

Sun set at 5*h*. 53*m*.

Stronger Light at { 7*h* 15*m*., &c., to 9 0 } Diffuse at 7*h*. 15*m*. and 8*h*. 0*m*.

Sky very brilliant, and everything favorable for observations. Thought I saw pulsations, and made the following record:

h. *m*.

* * *

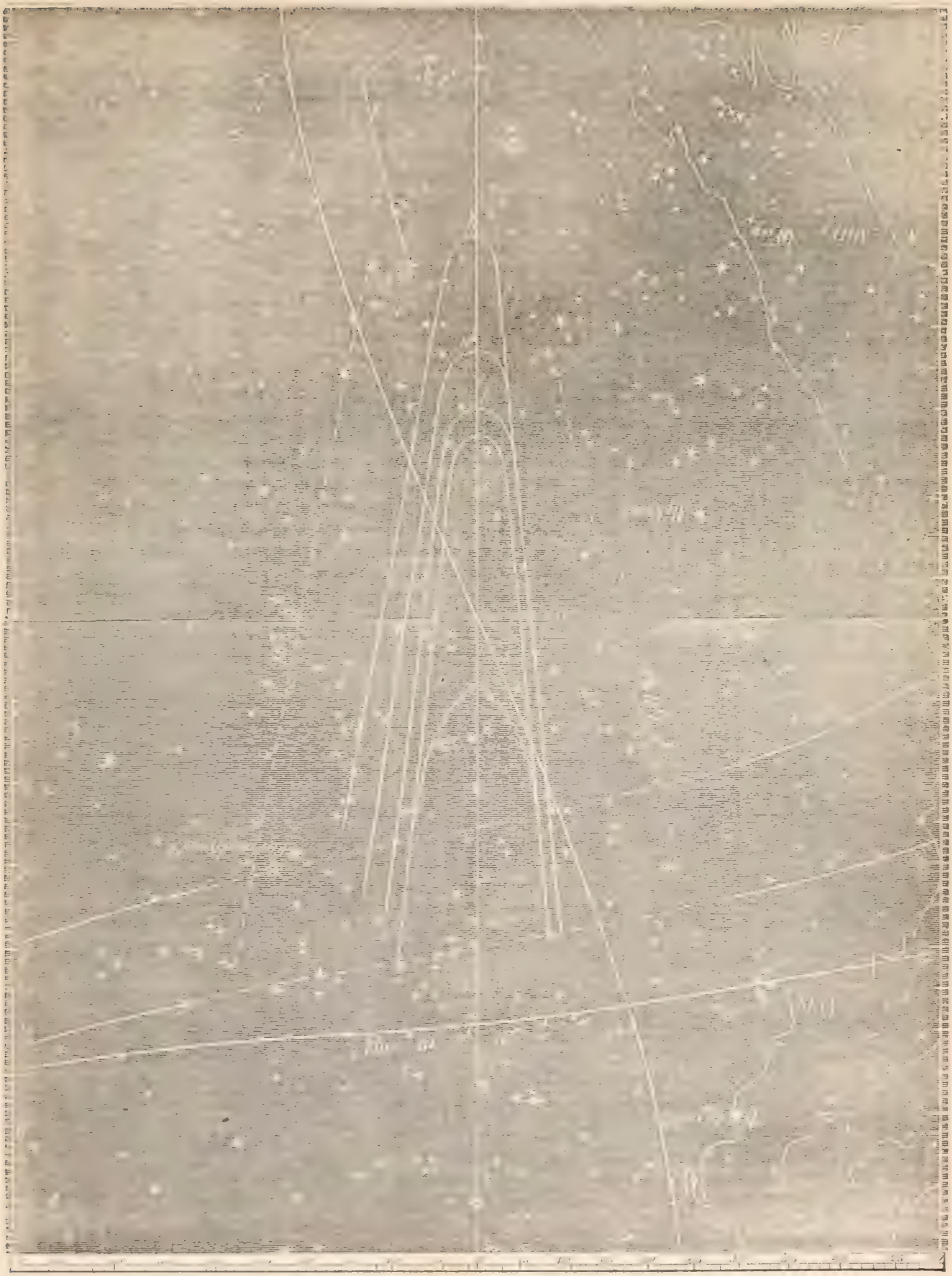
"At 7 25, very bright, and at *b*.
7 27, dimming, at *a*.
7 28, dim do.
7 31, brightened.
7 32, bright, at *b*.
7 33, decidedly dimmed, at *a*.
(The dimming seems more rapid than the brightening.)
7 35, dim yet, and at *a*.
7 36, brightening.
7 37, bright, and at *b*.
7 38, quite bright, do.
7 40, still so.
7 41, do.
7 42, very bright now.
7 44½, still bright, and at *b*.
7 46, very bright, do.
7 48, dimmed somewhat.

(There seemed now to be slight pulsations in brightness, while the boundary continued permanent at *b*.)

h. *m*.

At 7 50, brightened.
7 51, quite bright.
7 54, still bright.
7 57, do.
8 0, considerably dimmed.
8 5, brightened once more.
8 6, quite bright.
8 7, the upper part of the Zodiacal Light is now much brighter than before, and the lower part is dimmed.
8 10, lower part brightened again.
8 12, still so.
8 17; it seems to be permanent as at last—bright below, and tapering off; brightness very gradual to the upper end; the boundary as in the chart at 8."

At 9 o'clock the Zodiacal Light was still very distinct, and with boundaries evidently much extended (so also last night); but so dim, that it was difficult to get them reliably: but I made the attempt.



No. 278.

JANUARY 11th, 1855: Evening.

Lat. 8° 47′ N.: Lon. 79° 31′ W.

Sun set at 5*h*. 54*m*.

Stronger Light at $\left\{\begin{matrix}7h.\ 15m., \text{ \&c., to} \\ 9\end{matrix}\right\}$ Diffuse at 7*h*. 15*m*. and 9*h*. 0*m*.

Stars remarkably brilliant in a sky almost black; night extremely favorable for observations. At 7ʰ 15ᵐ the effulgence below the zigzag very strong. Watched for pulsations; sometimes doubted whether there were any at all; sometimes was certain that there were. My notes at the time were as follows:

h. *m*.

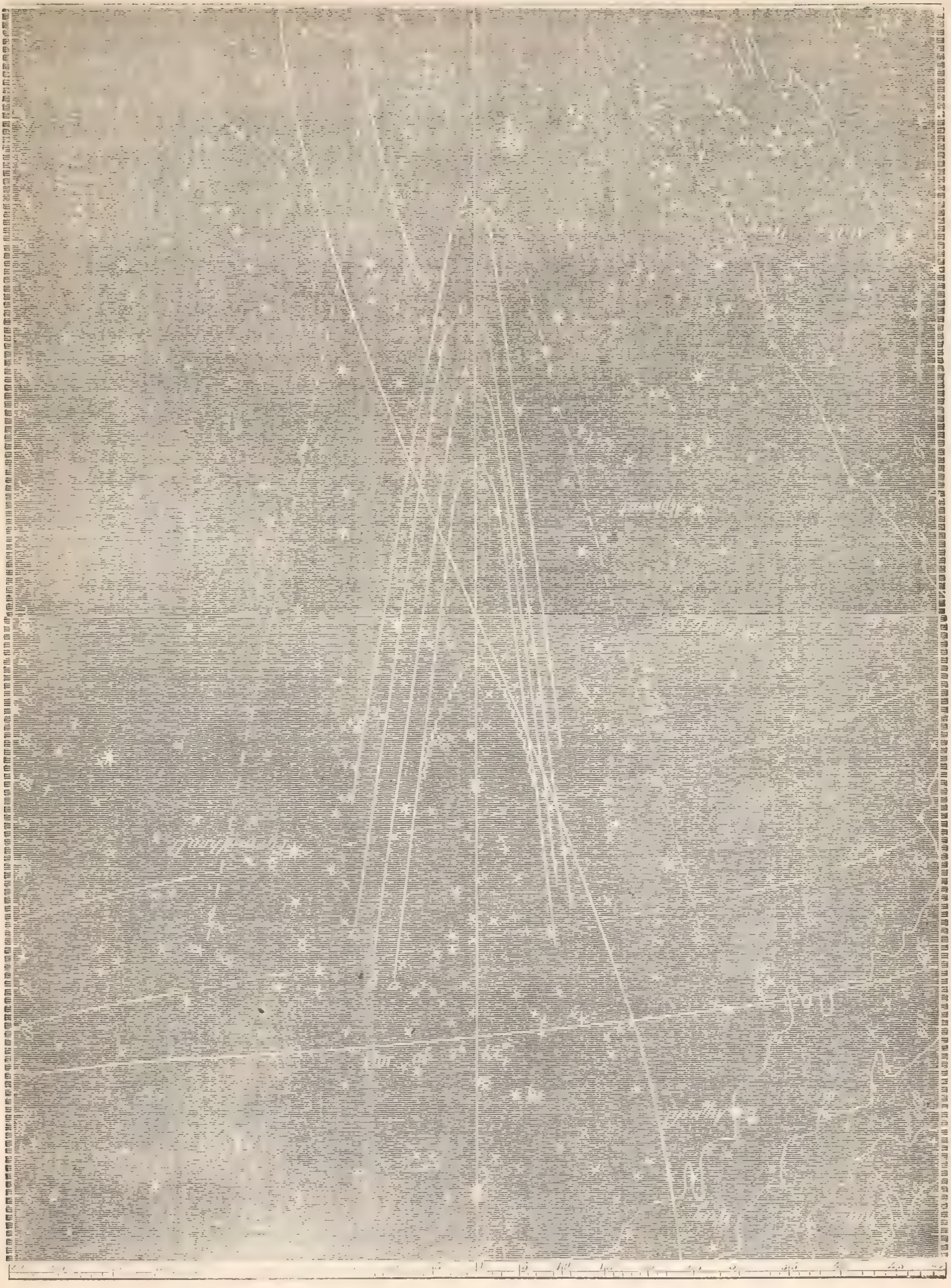
"At 7 24, at *b*, and bright.
7 26, exceedingly bright.
7 28, still do.
7 30½, has just dimmed decidedly, and at *a*.
7 32, bright, and at *b*.
7 34, very bright.
7 35½, dimming.
7 36, evidently dimmed.
7 37, quite dim, and at *a*.
7 37¾, brightening.
7 39, bright, and at *b*.
7 40, quite bright.
7 41, very bright.
7 42, do. and no mistake about it.
7 43, still so.
7 44, do.
7 45, do.
7 46, do.

h. *m*.

* * *

At 7 49, now quite bright. There seem still to be pulsations; but they are so badly marked now, that I cannot catch their periods.
7 50, very bright. The effulgence below the zigzag now much dimmer than at first.
7 55, the light has almost suddenly extended to *c*.
7 57, dimmed once more.
7 58, quite dim.
7 59, has brightened.
8 0, has brightened considerably.
8 1, quite bright.
8 2, do. do.
8 5, still very bright.
8 7, do. do., seems now to be permanent.
8 10, still the same."

At 9 o'clock Zodiacal Light still well marked, and gave reliable boundaries.



No. 279.

JANUARY 12th, 1855: Evening.

Lat at 8*h*., 7° 7′ N.: Lon. 79° 26′ W.
Sun set at 5*h*. 57½*m*.
Stronger Light at 7*h*. 20*m*, &c.: Diffuse 7*h*. 30*m*. and 8*h*. 20*m*.

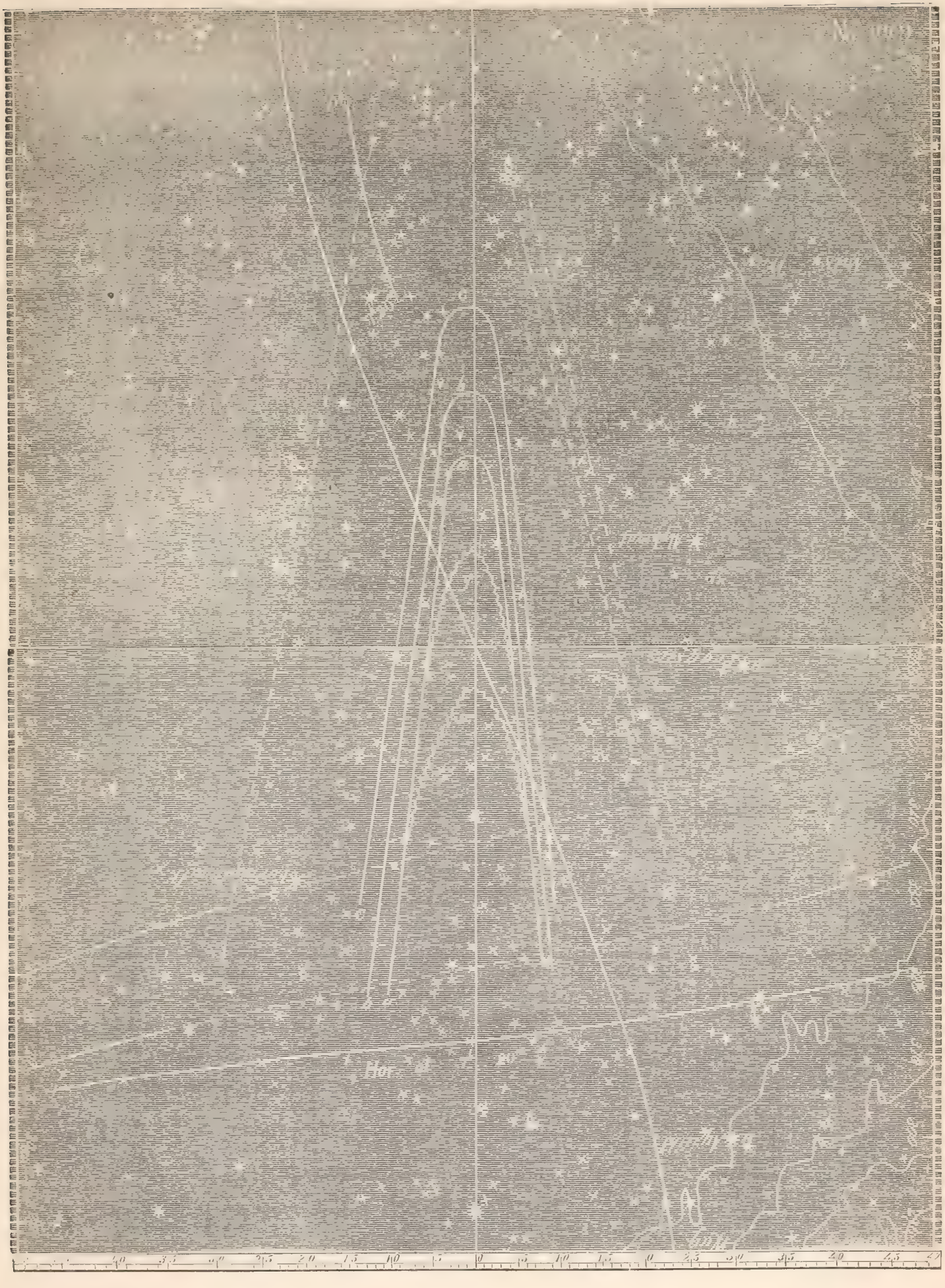
Sky very fine for observations. Through want of care, I was a little later on deck than I ought to have been. The following is my record for the evening:

h. *m*.
"At 7 25, bright, and at *b*.
7 29, dim, and at *a*.
7 31, bright, and at *b*.
7 32, very bright, do.
7 34, dim, and at *a*.
7 36, still so.
7 37, very bright, and at *b*.
7 38, still so.
7 38½, dim, decidedly, and at *a*.
7 41, brightening.
7 42, bright.
7 43, still so.
(I notice, this evening, a decided difference in the boundaries on the right or northward, between the Light when bright and when dim.)
7 44, still as at last.
7 44½, very bright, at *b*.
7 45, do. do.
7 46, dim, and at *a*.
7 47, do. do.
7 48, bright, and at *b*.
7 49½, still so.
7 50, very bright, do.

h. *m*.
At 7 51, strikingly so, and at *b*.
7 52, } do.* do.
7 53½, }
7 54½, dimmed.†
7 56½, brightening.
7 57½, bright, and at *b*.
8 0, the boundaries called *b* have been gradually extending beyond that, and have now got to *c*. The zigzag has also just now ascended from *x* to *y*.
8 3, as at last, quite bright.
8 4, } still so.
8 5, }
8 7, } there seem to be pulsations in brightness,
8 9, } but not in boundaries.
8 10, dimmed, and boundaries not as distinct as before.
8 12, same as last.
8 13½, has just brightened considerably.
8 16, still as at last.
8 20, do. do. seems to be permanent at this.
9 0, the Zodiacal Light still decidedly marked in the sky, but gives no reliable boundaries."

* It may be well to repeat here, that, in these annotations about fluctuations, "do." means *continued still* at the same place.

† Passed Midshipman B——— was with me at this change, and remarked upon it at once, even before I had noticed it

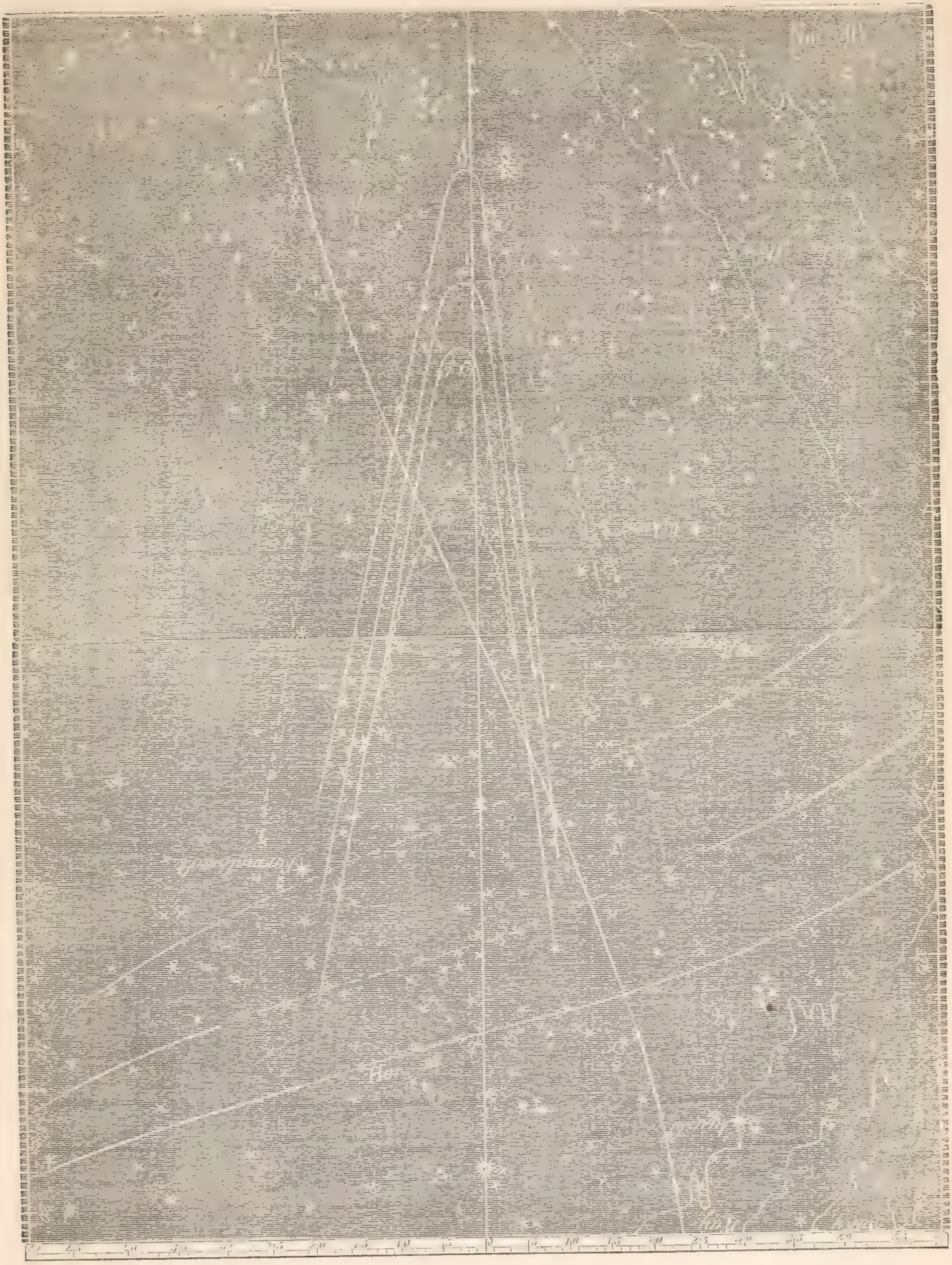


No. 280.

JANUARY 15th, 1855: Evening.

Lat. at 8*h*., 21′ N.: Lon. 86° 37′ W.
Sun set at 6*h*. 9*m*.
Stronger Light at 7*h*. 15*m*. to 9*h*.: Diffuse at 7*h*. 30*m*.

Clouds since the 12th. Sky this evening not in the best condition for observations; somewhat hazy, and troubled, also, by passing clouds. I did the best I could, and got boundaries, which are remarkable for their great divergence from the ecliptic on the southern side. These boundaries were very carefully taken; but I do not consider them *fully* reliable: must wait to get others hereafter; still, however, these outlines appeared to be fairly marked in the sky. The effulgence within the zigzag was wonderfully great this evening; the Diffuse Light was not well defined. There were evidently pulsations, but the clouds prevented my making record of them. The Light at 9ʰ was dim, and its boundaries were very badly marked.

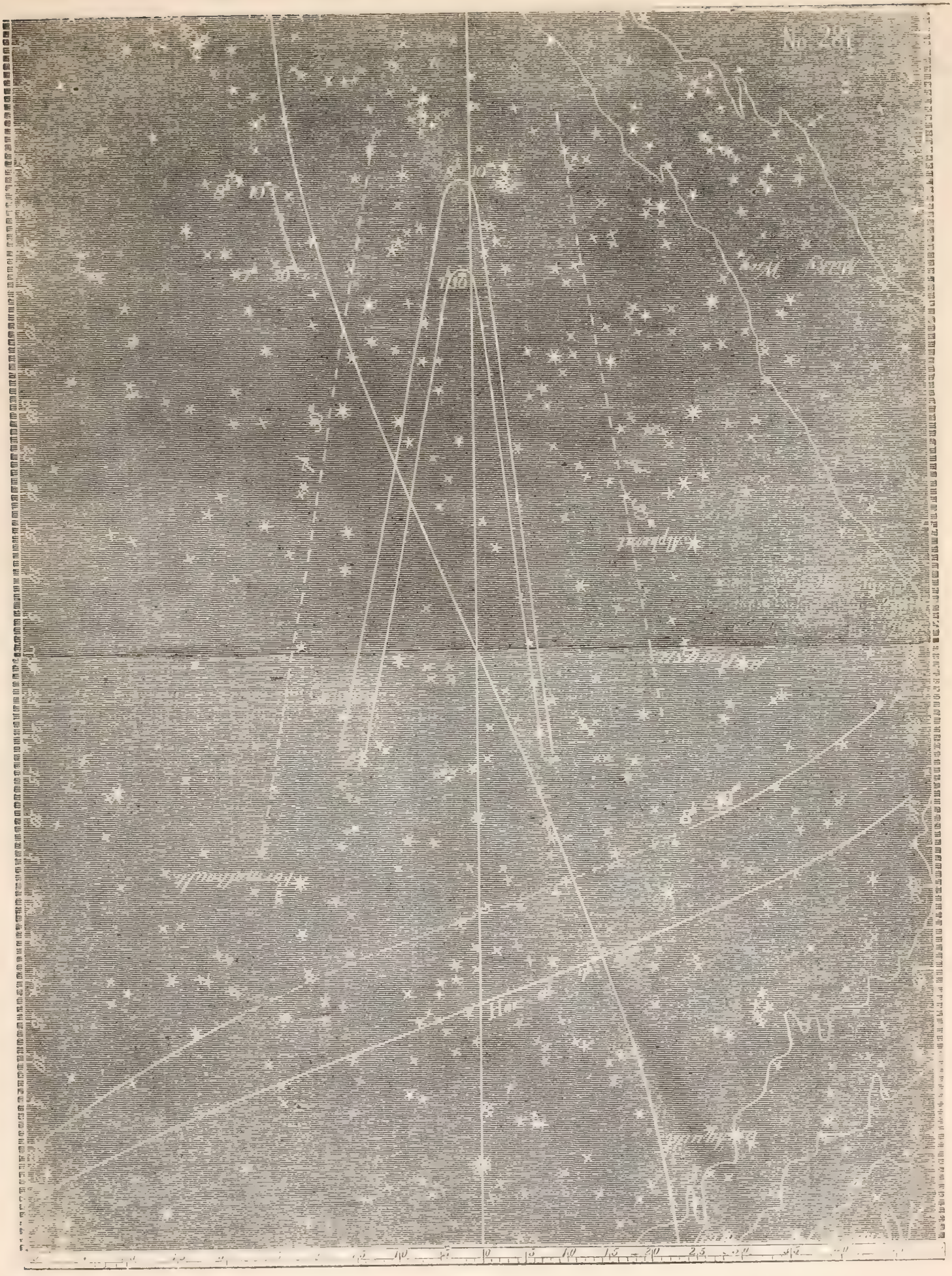


No. 281.

JANUARY 17th, 1855: EVENING.

Lat. at $8h.$, 2° 54′ S: Lon. 81° 53′ W.
Sun set at $6h.$ $14m.$
Stronger Light at $7h.$ $30m.$ and $8h.$ $10m.$: Diffuse at $7h.$ $30m.$

Clouds all last night; also this evening, till half-past 7, when I was able to get an observation. It was ont a very satisfactory one, however, as there still were clouds along the horizon; and I could get boundaries only towards the upper part of the Zodiacal Light; and, even there, the sky was not favorable, on account of a general dimness or slight haziness. There seemed to be pulsations, but the region of them was troubled by the clouds, and I did not attempt to record them. At 8^h 10^m, sky still the same. Soon afterwards it was quite clouded over.



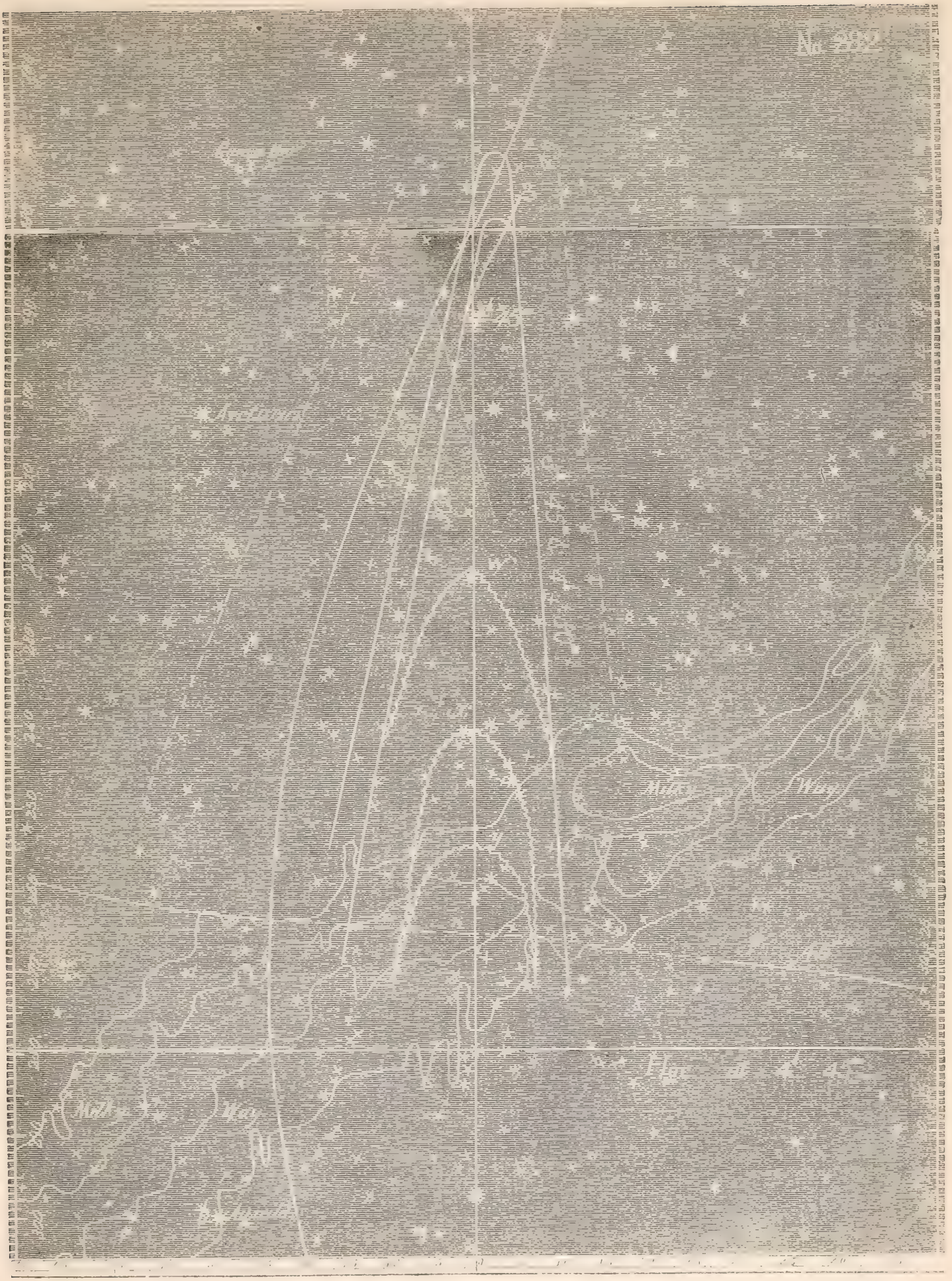
No. 282.

JANUARY 18th, 1855: Morning.

Lat. at 4*h*., 3° 40′ S.: Lon. 82° 20′ W.
Sun rose at 6*h*. 4½*m*.
Stronger Light at 3*h*. 45*m*. and 4*h*. 30*m*.: Diffuse at 4 o'clock.

Was on deck at 3 o'clock. The Zodiacal Light was then very distinct, but I was prevented from getting outlines by passing clouds till $3^h\ 45^m$. After 4 o'clock, the sky was remarkably fine for observations, and I continued making them with the greatest care. My notes are thus: "$4^h\ 5^m$, the Zodiacal Light has just brightened up considerably, more especially below the zigzag line *w*; $4^h\ 20^m$, now a great effulgence within the zigzag *x*, very marked in strength and in its boundaries; $4^h\ 25^m$, the *whole* Zodiacal Light very bright, but the marked effulgence within *x* still continues; $4^h\ 50^m$, this extreme effulgence has now sunk to the boundary *y*, and is very striking: its bounds well marked; $4^h\ 54^m$, the Light is spreading laterally—doubtless the beginning of dawn; $4^h\ 56^m$, dawn has decidedly come."

At $4^h\ 20^m$, noticed that the stars of the fifth magnitude, about 42 in the left foot of Ophiuchus, also 40 of same, were very distinct, though in the middle of this effulgence.


No. 232
Andromeda
Milky Way
Milky Way
Milky Way
Andromeda

No. 283.

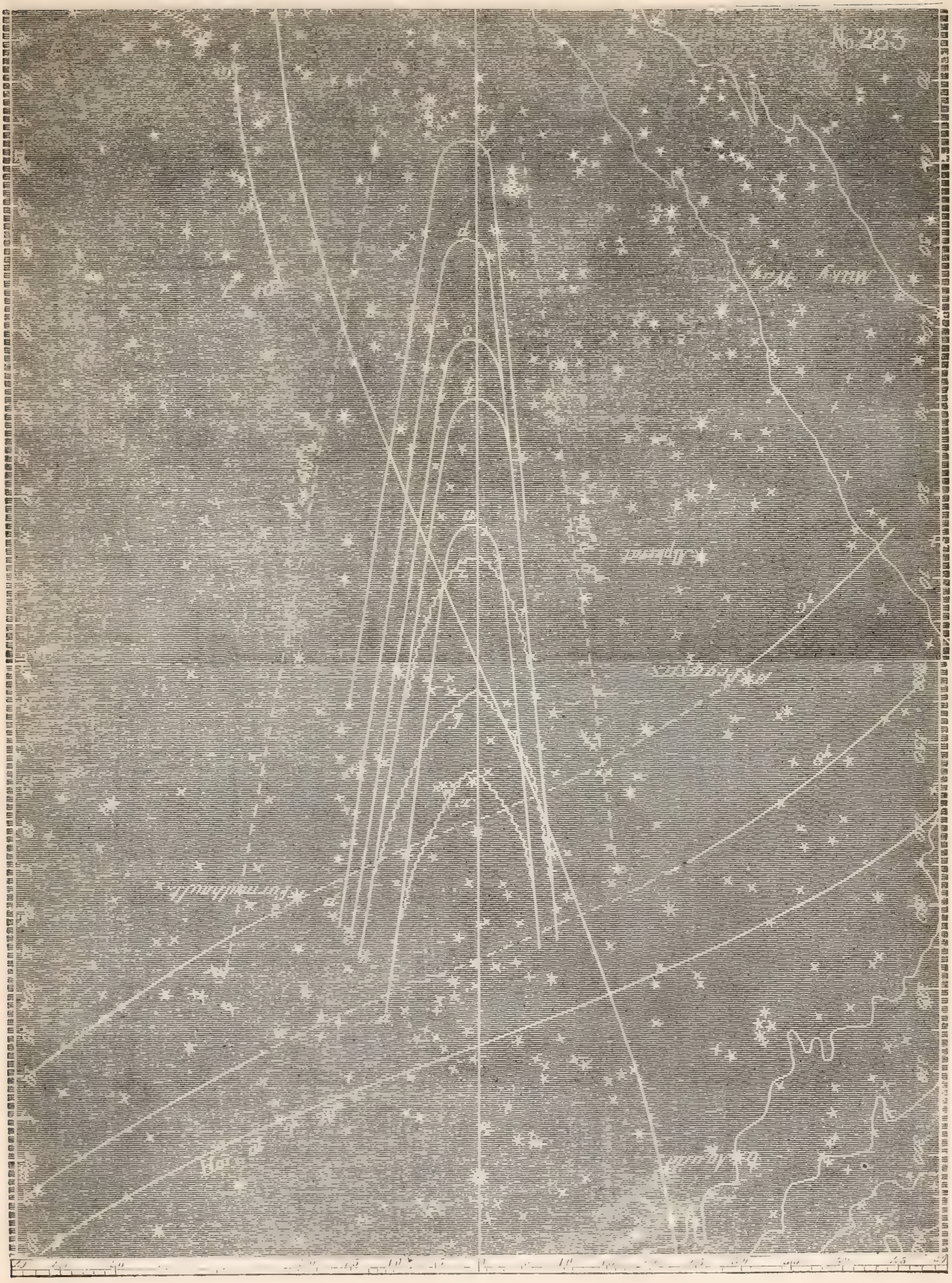
JANUARY 18th, 1855: Evening.

Lat. at 8*h*., 5° 7′ S.: Lon. 82° 14′ W.
Sun set at 6*h*. 18*m*.
Stronger Light at 7*h*. 20*m*., &c., to 9*h*.: Diffuse 7*h*. 40*m*. and 8*h*.

A remarkably fine, clear night, and everything very favorable for observations. Began to record them at $7^h\ 18^m$, when the Zodiacal Light was bounded as in the chart at *a a*. My record is thus:

h. *m*.
"At 7 25, boundaries at *a*, and bright within the zigzag.
7 26, the brightness has extended to the zigzag *y*; boundaries at *b*.
7 27, at *x*, and dim.
7 27½, quite dim.
7 29, brightening.
7 31, bright, and bounded by *b b*.
7 33, still so.
7 33½, very bright.
7 34½, dimming.
7 36, brightening.
7 36½, bright, and at *b*.
7 37, quite bright.
7 38, still so.
7 39½, dimming.
7 40, dim, and at *a*.
7 41, brightening.
7 42, bright, and at *b*.
7 43, very bright, do.
7 43½, remarkably bright, and bounds have extended to *c*.
7 47, still so.

h. *m*.
At 7 47½, exceedingly bright, and at *c*.
7 50½, still so. The effulgence has ascended to *z*.
7 52, do. do.
7 54½, effulgence very great; bounds at *c*.
(The effulgence not greater than at first, when it reached only to *x*; but it is now more striking, inasmuch as it ascends higher up to *z*.)
* * *
7 56¼, has just brightened somewhat.
7 58, dimmed a little, but bounds at *c*.
7 59, brightening.
8 0, bright once more. (How fast and how strikingly the angle of inclination with the horizon changes!)
8 4, is quite bright, and extends now beyond *c c*.
8 9, bounds at *d d*; but it is not so bright as before, nor are the boundaries so well defined.
8 13, pulsations appear to have ceased: the Light much diminished in strength.
9 0, the Light distinct, but very dim, and its boundaries can scarcely be got reliably."

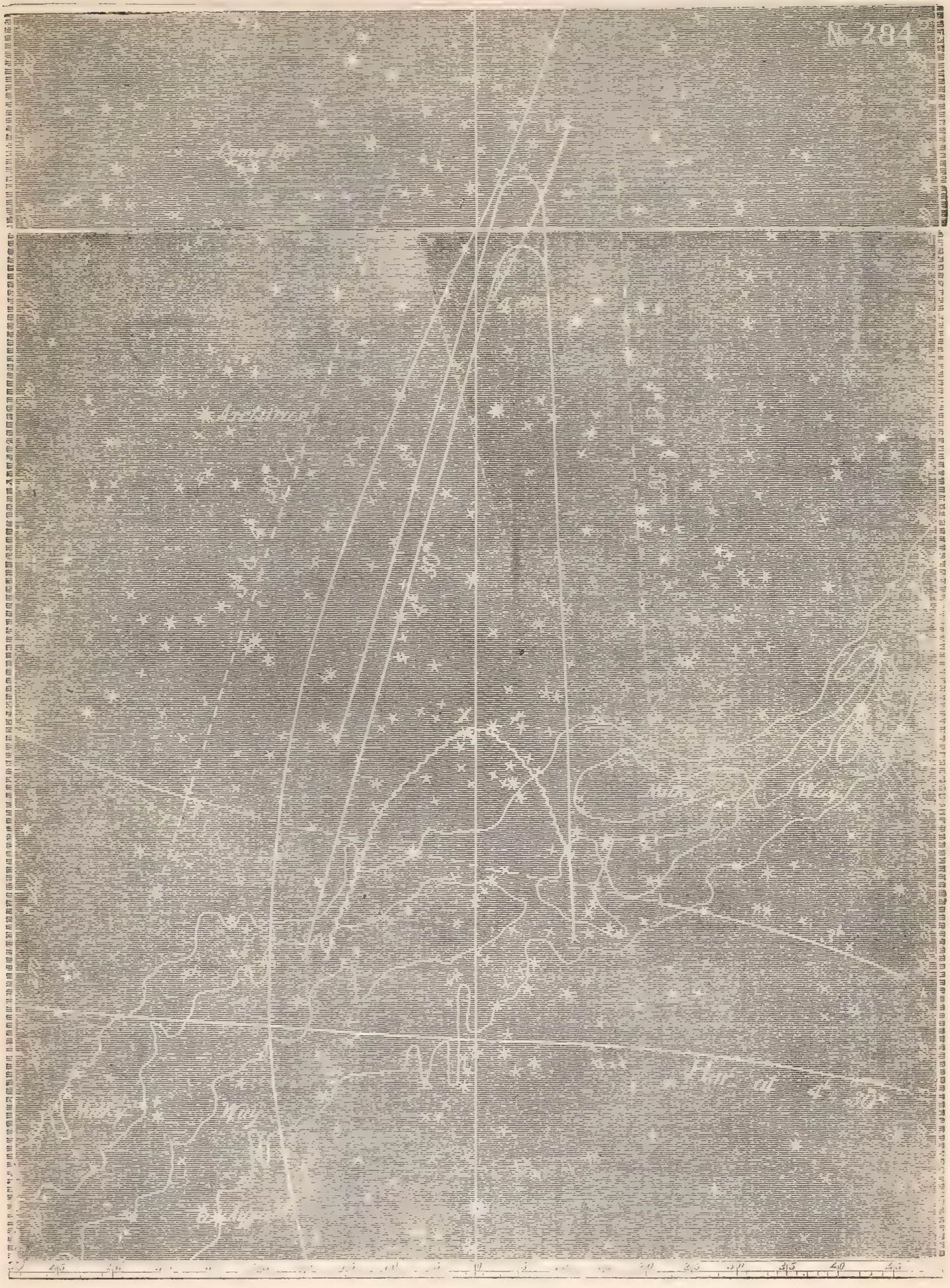

No 283

No. 284

JANUARY 19th, 1855: Morning.

Lat. at 4*h*., 5° 57′ S.: Lon. 81° 52′ W.
Sun rose at 6*h* 2*m*.
Stronger and Diffuse Light at 3*h*. and 4*h*. 30*m*.

Was on deck at 3 o'clock. Found the sky only tolerably favorable; not very bright, and clouds also passing. The boundaries easily got on the northern side, where they were well marked, and the change from the Zodiacal Light brightness to the darker sky is sudden and well defined; but, on the southern side, the change is scarcely perceptible, the sky beyond the boundaries still keeping a considerable degree of brightness. On that account, I could not get the boundaries of the Diffuse Light on the southern side. (A very heavy dew falls now at night.) At 4^h 30^m, the atmosphere dim. The Zodiacal Light was bright up to the zigzag x, but not at its brightest. Very difficult still to get reliable boundaries on the southern side. At 4^h 35^m, up to x, brightening; 4^h 40^m, do. do.; but clouds near the horizon and the dimness of the sky discouraged me from further efforts at observations.

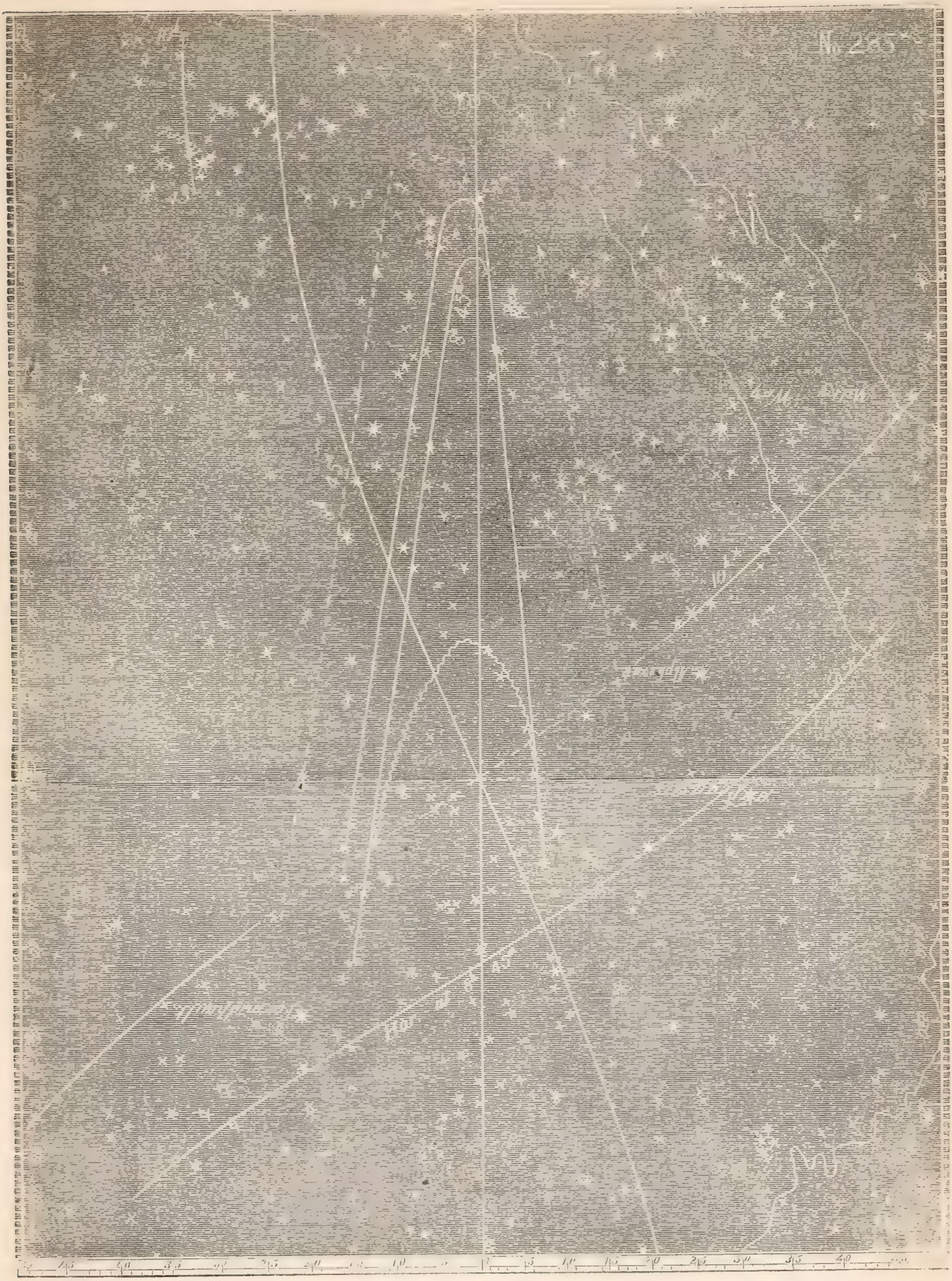

N. 284
Aquila
Antinous
Ophiuchus
Hercules
Draco
Ursa Major
Ursa Minor
Cepheus
Cassiopeia
Perseus
Auriga
Gemini
Taurus
Aries
Pisces
Aquarius
Capricornus
Sagittarius
Scorpio
Libra
Virgo
Leo
Cancer

No. 285.

JANUARY 20th, 1855: Evening.

Lat. at 8*h*., 9° 52′ S.: Lon. 80° 33′ W.
Sun set at 6*h*. 26*m*.
Stronger Light at 8*h*. 45*m*. and 9*h*. 15*m*.: Diffuse at 8*h*. 45*m*.

Clouds last evening and this morning. Moon did not set, this evening, till $8^h\ 45^m$, when the night became very favorable, being clear and bright. The effulgent portion, as bounded by the zigzag, was still worthy of note; and, at 9 o'clock, though greatly dimmed, it could be distinguished from the other portions. At 10^h the Zodiacal Light still continued; the boundaries apparently as at $9^h\ 15^m$. It was now, however, very faint.



No. 286.

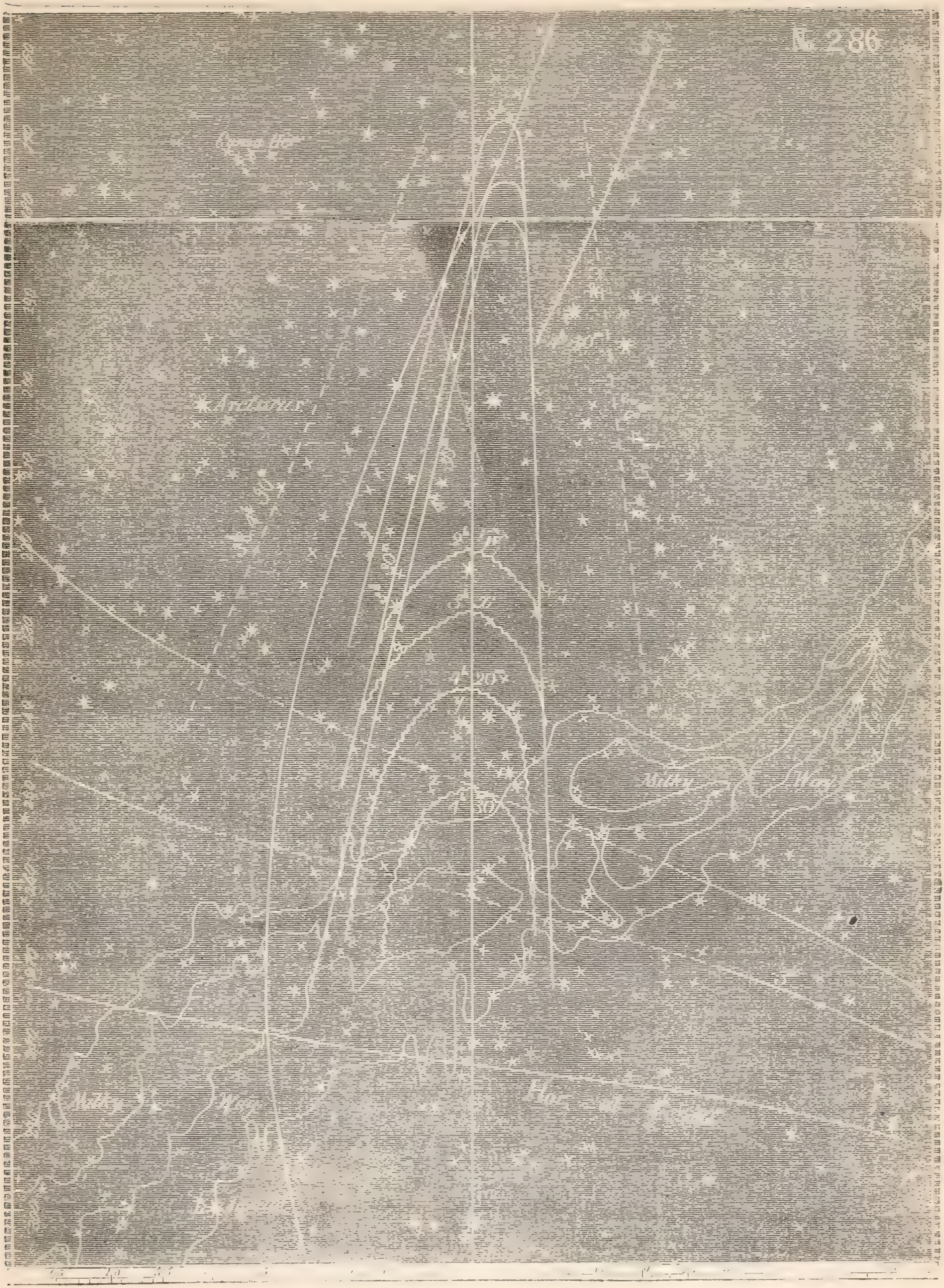
JANUARY 22d, 1855: Morning.

Lat. at 4*h*., 12° 46′ S.: Lon. 79° 28′ W.

Sun rose at 5*h*. 53*m*.

Stronger Light at { 2*h*. 0*m*. / 3 0 / 4 30 } Diffuse at 3*h*. and 4*h*. 30*m*.

21st was Sunday. Was on deck at $1^h\ 45^m$, and found the Zodiacal Light very distinct and well marked; passing clouds prevented my getting boundaries till 2 o'clock, at which time the sky was extremely favorable: so it continued till daybreak. At 2^h there was already a more effulgent part, which I have marked by the zigzag *w*. At 3^h the effulgence was down to *x*, and was very strong; sky remarkably fine for observations. No dew. On deck again at $4^h\ 15^m$, and now had some difficulty in making out the southern boundaries of the Stronger Light, which I had not experienced before. The Light there passed off almost insensibly into the Diffuse Light. Still, I was able to get what I think are reliable results. At $4^h\ 20^m$ the boundary of the effulgent part had got down to *y*, and the effulgence was less brilliant; "$5^h\ 35^m$, the light is spreading, giving signs of dawn; spreads fastest on the southern side; $4^h\ 40^m$, dawn has come." At $4^h\ 40^m$ there were still faint traces of the Zodiacal Light at its upper end, dawn not having reached there yet.

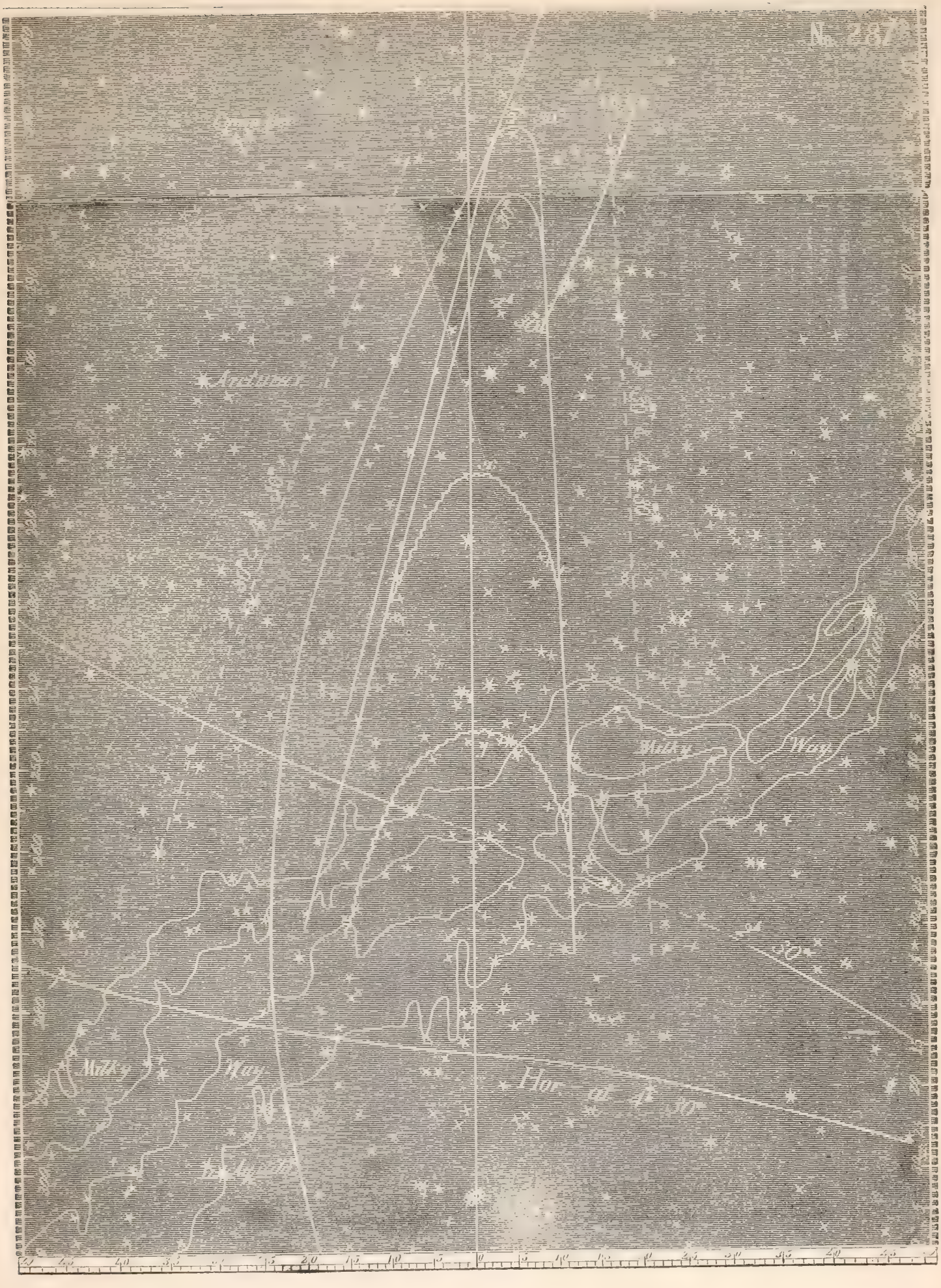

N 286
Andromeda
Aries
Taurus
Perseus
Auriga
Cassiopeia
Cepheus
Pisces
Cetus

No. 287.

JANUARY 23d, 1855: Morning.

Lat. at 4*h*., 14° 44′ S.: Lon. 78° 51′ W.
Sun rose at 5*h*. 51*m*.
Stronger and Diffuse Light at 2*h*. 30*m*. and 4*h*. 30*m*.

Was on deck at 2ʰ 30ᵐ; sky very clear and bright. Had some difficulty in getting boundaries of the Diffuse on the south, as they are not well marked. The Light was strongest of all below the zigzag *x*. At 4ʰ 20ᵐ the effulgence extended only to *y*; but it was very brilliant. Sky still very good for observations; but being very unwell, I did not continue them further.

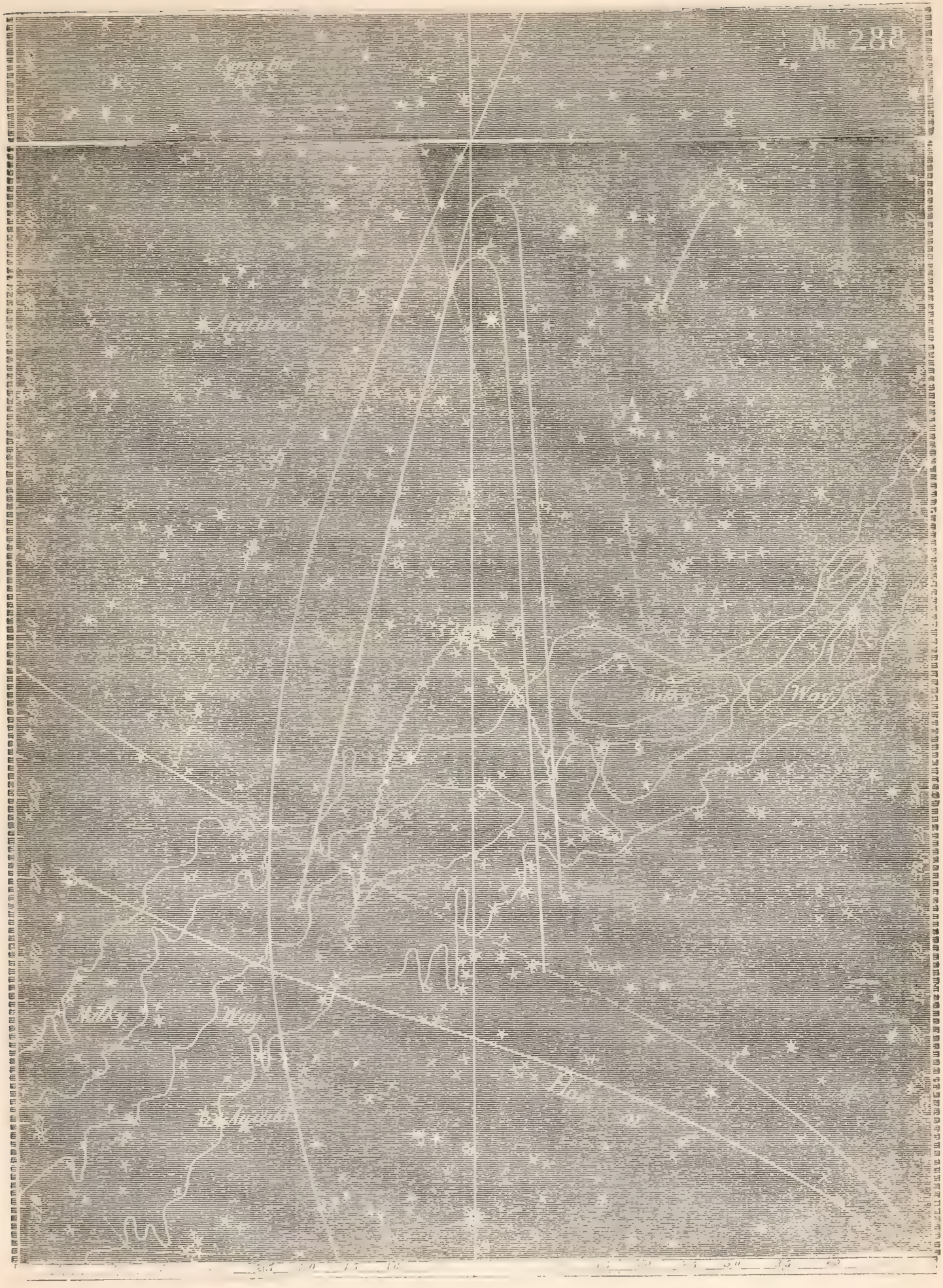

N. 287
Milky Way
Milky Way
Milky Way
Pleiades
30°
30°

No. 288.

JANUARY 30th, 1855: Morning.

Lat. at 4^h, 29° 7′ S.: Lon. 72° 49′ W.
Sun rose at 5^h. $32\frac{1}{2}^m$.
Stronger Light at 3 and 4 o'clock: Diffuse at 3 o'clock.

Clouds in the morning, moon and clouds in the evening, ever since my last date (23d). The moon set this morning just before 3^h, after which I was able to get observations as in the chart. Morning very clear and bright, blowing almost a gale; heavy dew. The Zodiacal Light very dim at 3 o'clock; and, at 4^h, not as bright as formerly. The effulgence beneath the zigzag was strongly marked. Dawn at $4^h\ 8^m$.

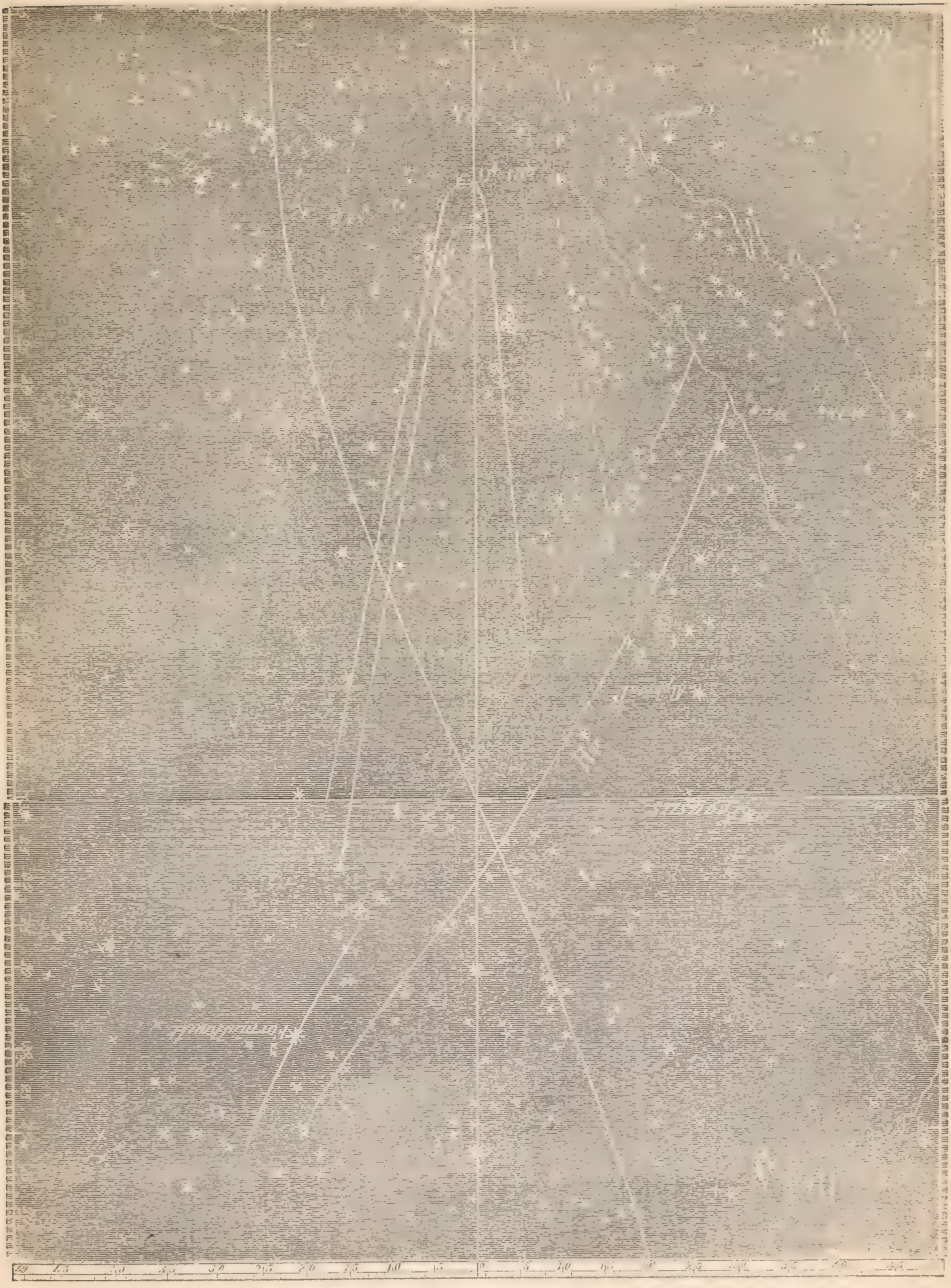

No. 284
Arcturus
Milky Way
Milky Way

No. 289.

FEBRUARY 6th, 1855: Evening.

Lat. 33° 1′ S.: Lon. 71° 41′ W.
Sun set at 6*h*. 56*m*.
Stronger Light at 8*h*. 30*m*. and 9*h*. 15*m*.: Diffuse at 8*h*. 30*m*.
Zenith point at 8*h*. 30*m*., Lat. 56° 29′ S.: Lon. 82° 30′. At 9*h*. 15*m*., Lat. 56° 29′ S.: Lon. 97° 30′.

Clouds (and the moon in the morning) since my last date (February 3d) until this evening, when the sky was clear, and, except a slight haziness, was good for observations. The ecliptic is, however, so near the horizon in the evening, that the Zodiacal Light is by no means brilliant. Still I was able, by very careful observation, to get what I consider reliable boundaries. The twilight is now very protracted, which adds to the dimness of the Light. At $9^h\ 15^m$ it was quite dim, yet distinctly to be made out.

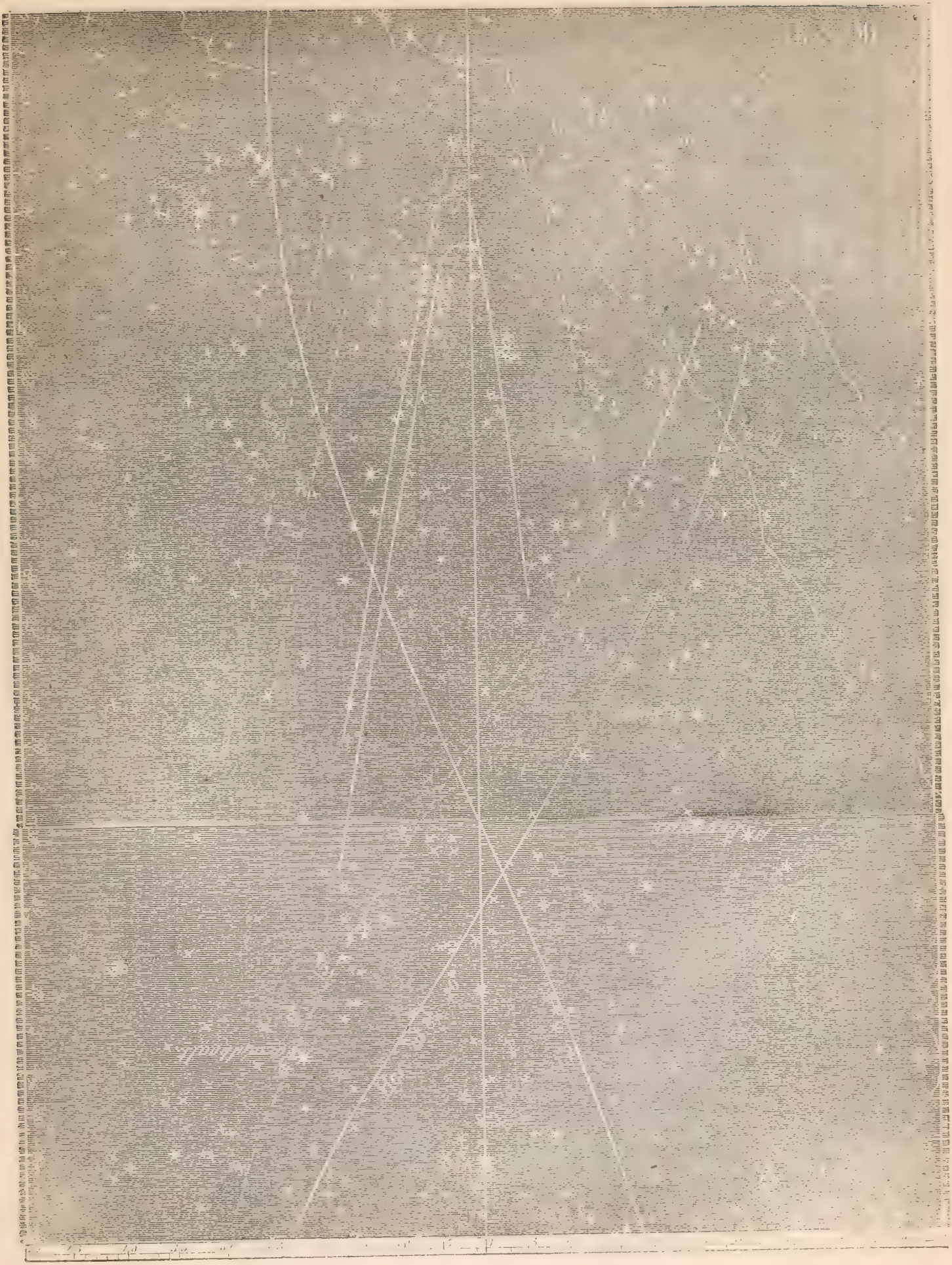


No. 290.

FEBRUARY 7th, 1855: Evening.

Lat. 33° 1′ S.: Lon. 71° 41′ W.
Sun set 6*h*. 55*m*.
Stronger and Diffuse Light at 8*h*. 20*m*. and 9*h*. 15*m*.
Zenith point at 8*h*. 20*m*., Lat. 56° 29′ S.: Lon. 80°. At 9*h*. 15*m*., Lat. 56° 29′ S.: Lon. 100°.

The night clear and very fine for observations. The twilight is very long, but at $8^h\ 10^m$ I could easily make out the Zodiacal Light; however, could not get reliable boundaries till $8^h\ 20^m$. At $9^h\ 15^m$ the Light was dim, but still was easily distinguished and well marked. At that hour I could not get the lower boundary of the Diffuse Light. At 10^h I could see a slight tinge in that part of the sky, evidently the Zodiacal Light; but I could not get boundaries; and, in fact, it was only a slight, faintly marked blush in the sky.

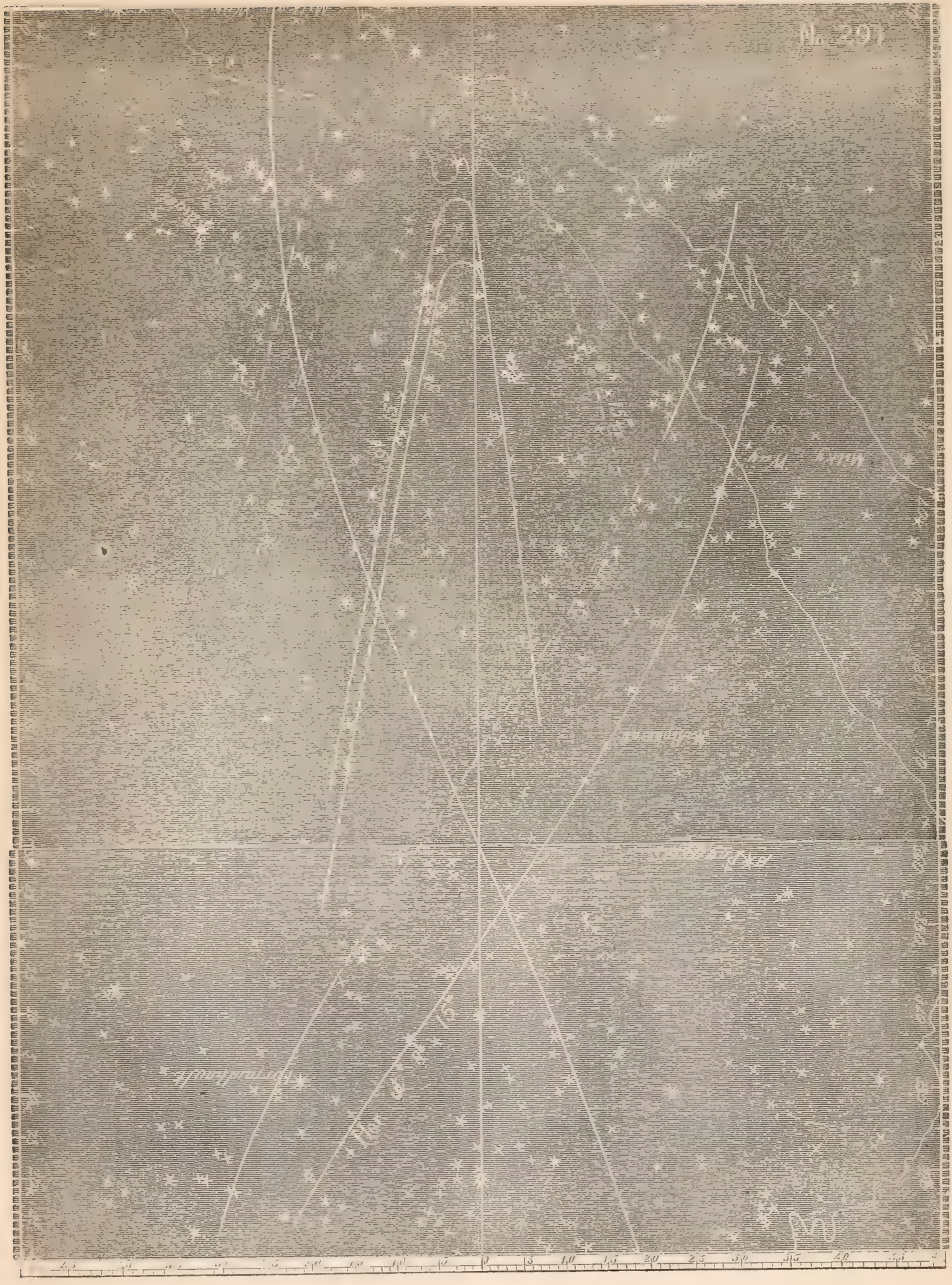


No. 291.

FEBRUARY 8th, 1855: EVENING.

Lat. 33° 1′ S.: Lon. 71° 41′ W.
Sun set at 6*h*. 54½*m*.
Stronger and Diffuse Light at 8*h*. 15*m*. and 9*h*. 15*m*.
Zenith point at 8*h*. 15*m*., Lat. 56° 29′ S.: Lon. 79°: At 9*h*. 15*m*., Lat. 56° 29′ S.: Lon. 101°.

Sky clear, and remarkably fine for observations. The Zodiacal Light was dim, but gave reliable boundaries, both at $8^h\ 15^m$ and $9^h\ 15^m$: at the latter hour, however, it is somewhat difficult to make them out.

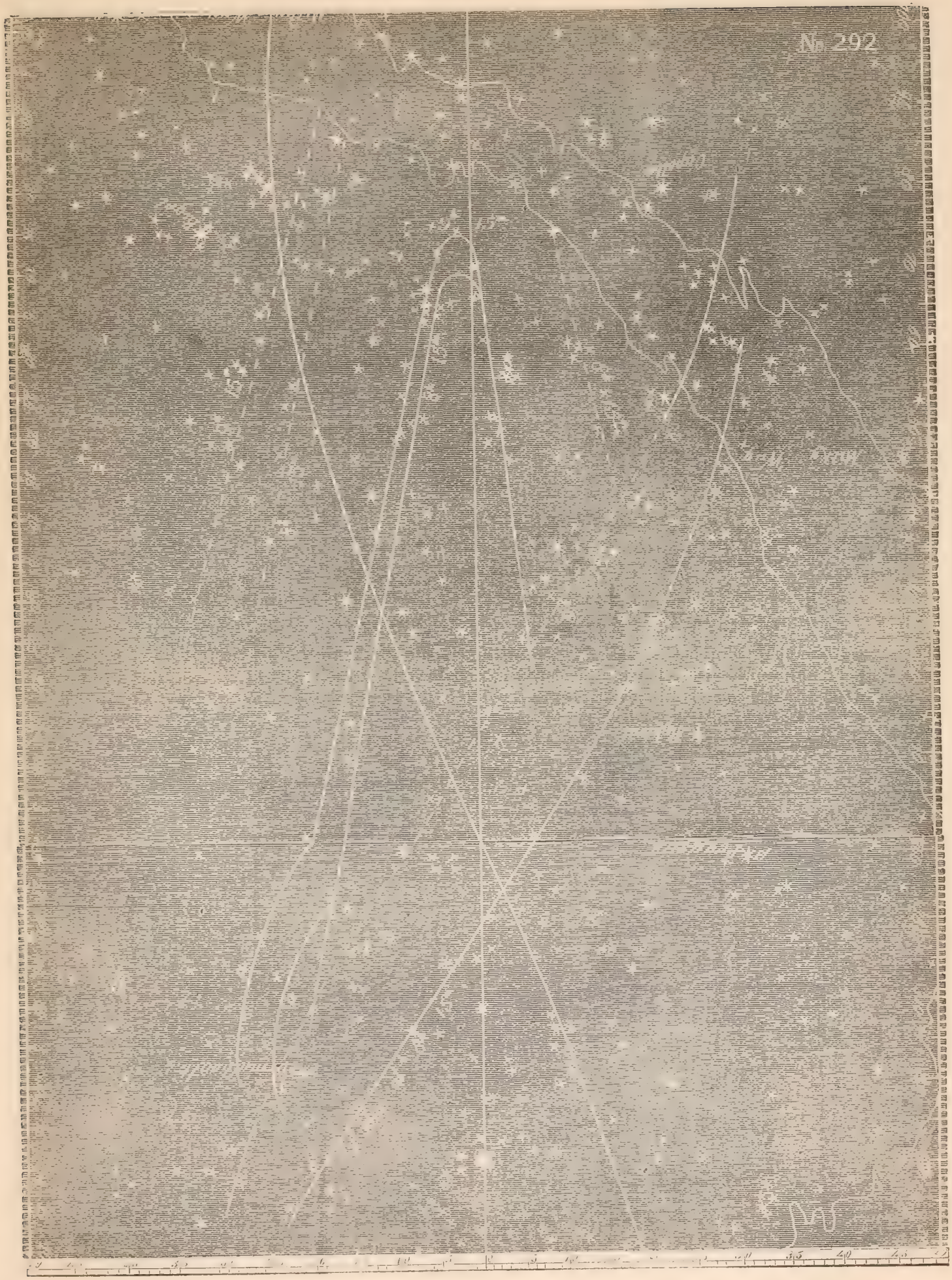

N. 20°

No. 292.

FEBRUARY 9th, 1855: Evening

Lat. 33° 1′ S.: Lon. 71° 41′ W.
Sun set at $6h.\ 53\frac{1}{2}m.$
Stronger and Diffuse Light at $8h.\ 15m.$ and $9h.\ 15m.$
Zenith point at $8h.\ 15m.$, Lat. 56° 29′ S.: Lon. 80°: At $9h.\ 15m.$, Lat. 56° 29′ S.: Lon. 103°.

Sky clear, and very favorable. It seemed to me that there were changes in the intensity of the Light; for, sometimes, it was very difficult to make out the boundaries; at others, they were tolerably plain. At $9^h\ 15^m$, however, the Light was very dim. I took boundaries this night again of the stretch of light $a\ a$, parallel to the horizon, although I consider it only atmospheric light.

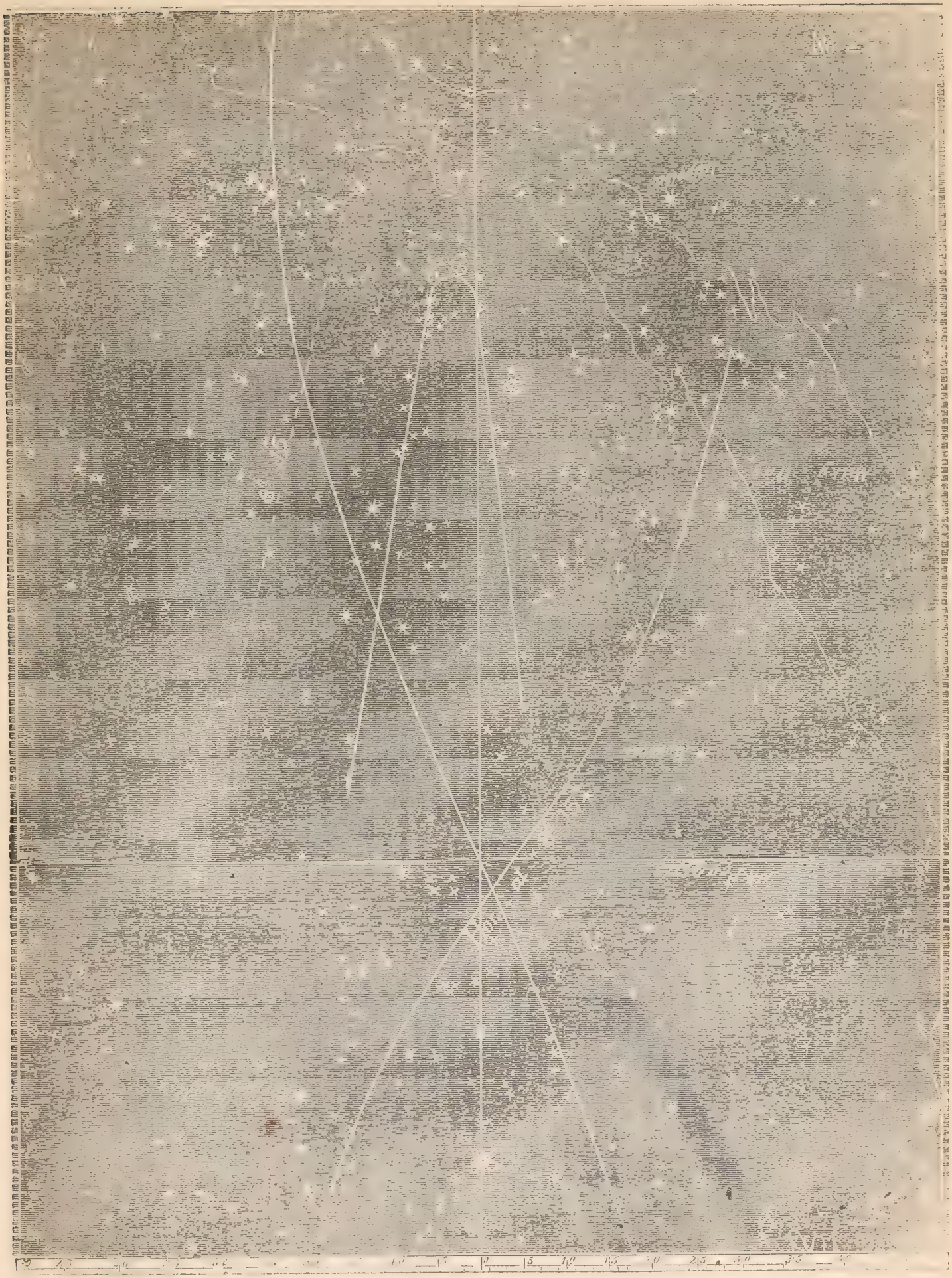

No. 292

No. 293.

FEBRUARY 12th, 1855: Evening.

Lat. at $8h.$, 35° 41′ S.: Lon. 73° 59′ W.
Sun set at $6h.\ 53\frac{1}{2}m.$
Stronger and Diffuse Light at $8h.\ 45m.$
Zenith point at $8h.\ 15m.$, Lat. 56° 29′ S.: Lon. 85°.

Clouds, since my last date, have prevented observations until this evening, when, at $8^h\ 15^m$, I was able to have one; the sky favorable above, but with passing clouds below. I thought that the lower or right-hand boundary of the Stronger Light, which was well defined, had evidently slid over towards the left, since my last observation. The other boundary was not so decidedly marked in the sky, but it also appeared to have moved on, as may be seen by a comparison of the charts. The lower boundary of the Diffuse could not be got, owing to clouds. After this observation, the sky was clouded over.

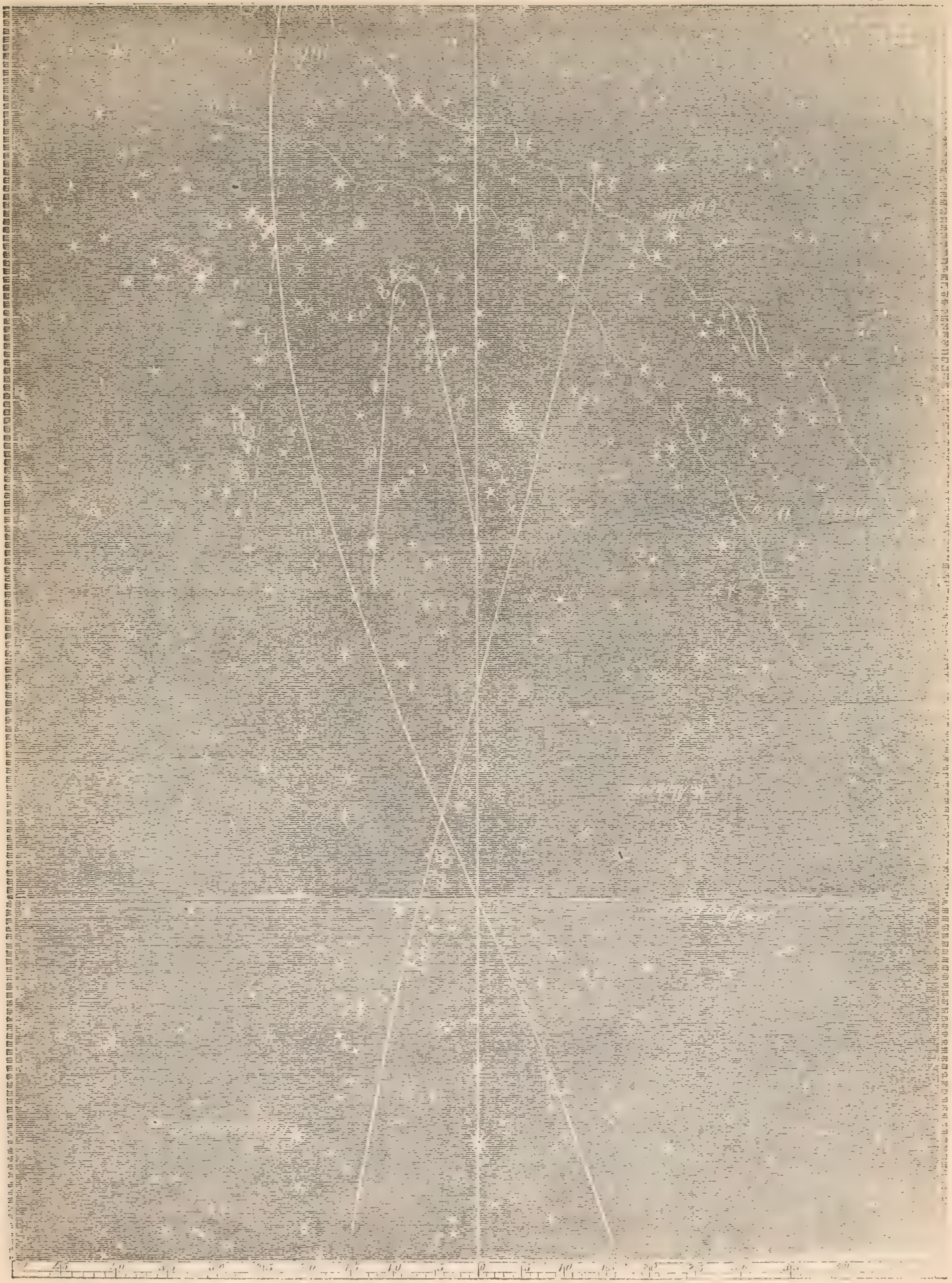


No. 294.

FEBRUARY 19th, 1855: Evening.

Lat. at 8*h*. 45*m*., 51° 57′ S.: Lon. 75° 58′ W.
Sun set at 7*h*. 14*m*.
Stronger and Diffuse Light at 8*h*. 45*m*.
Zenith point at 8*h*. 45*m*., Lat. 74° 59′ S.: Lon. 113°.

Clouds, ever since the last date, till this evening. The twilight now continues till a little after $8^h\ 30^m$, and by that time the ecliptic has got to be so near the horizon that the evening Zodiacal Light is of a very doubtful nature. The sky this evening was very clear, the stars shining with an intense brilliancy; but, although I tried very hard to see whether anything reliable could be made out, I found nothing satisfactory. On the chart are the boundaries of what seemed to me to be something like Zodiacal Light; but I cannot consider those of the Stronger Light to be at all reliable. That of the Diffuse is more certain: its lower boundary was not to be seen. The difficulty was, perhaps, increased by a very strong light in the southern sky, rising far above the horizon—probably the blink of ice about the southern pole. The air this evening was very sharp. At midnight the sky was still clear, and the stars were bright to a degree that I never saw before. At 2^h, rose to get a morning Zodiacal Light observation; but before I could determine any thing about it, clouds swept over the sky: so they remained.



No. 295.

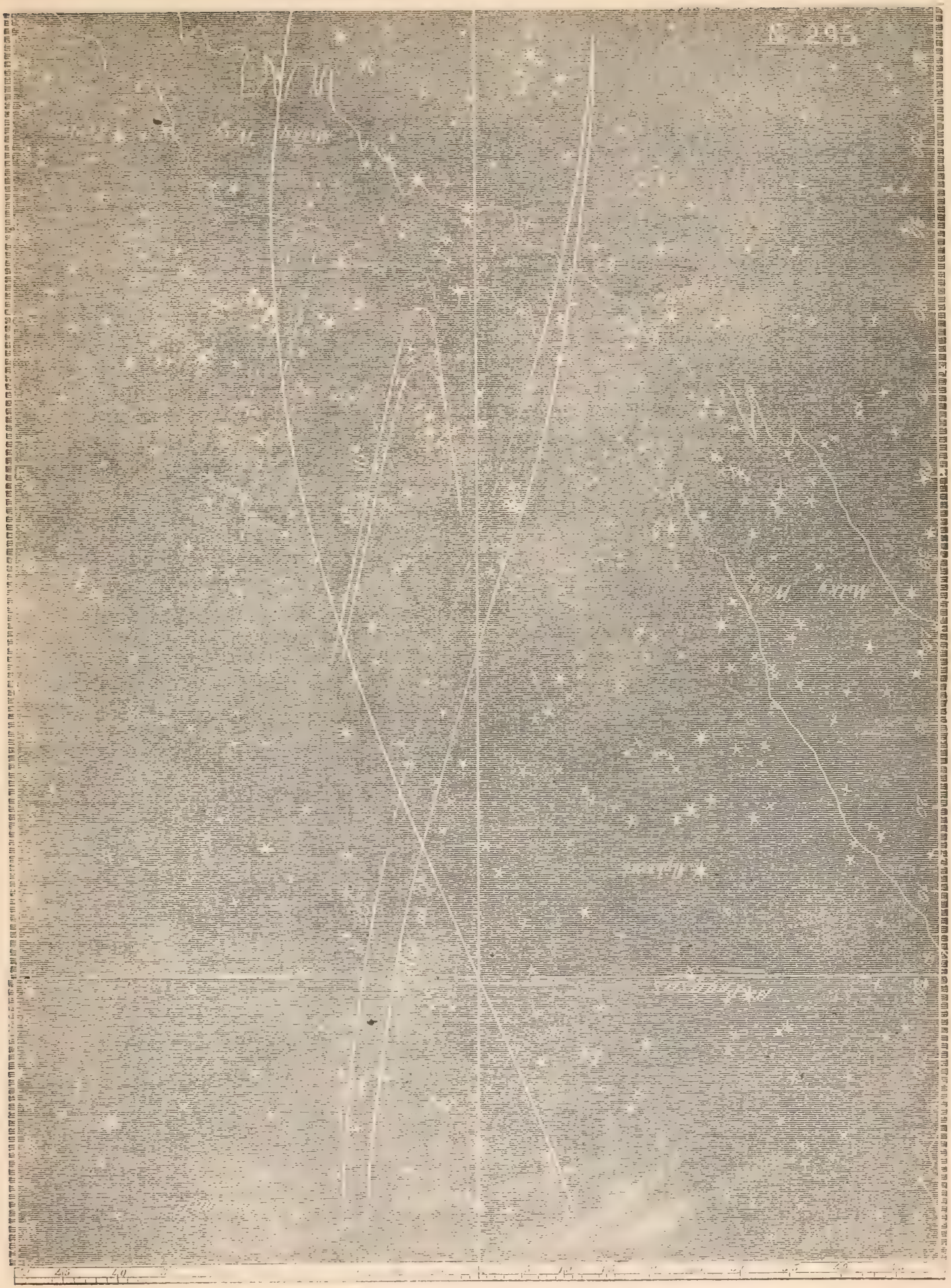
FEBRUARY 21st, 1855: Evening.

Lat. 53° 38′ S.: Lon. 70° 53′ W.: Port Famine, Straits of Magellan.
Sun set at 7*h*. 12 .
Stronger and Diffuse Light at 9*h*. and 9*h*. 30*m*.
Zenith point at 9*h* , Lat. 74° 25′ S.: Lon. 130° 30′. At 9*h*. 30*m*., Lat. 73° 30′ S.: Lon. 142° 30′.

Clouds last night. The sky this evening was perfectly clear, and very favorable for observations ; but the twilight is now very long (lasting till near 9 o'clock), and the ecliptic has now got down so near the horizon, even at its highest part, that it is very difficult to get boundaries of the Zodiacal Light that can be called reliable. Those of the Diffuse Light I think may be depended on. For the Stronger Light, I cannot speak so confidently ; but it was easily seen, at 9 o'clock, that the Stronger Light near the horizon, on the left of Saturn, was quite wanting on the right of that planet,* and the difference could be ascribed only to the Zodiacal Light. Dr. —— happened to be near me at the time, and readily saw this difference as well as myself. At 9^h 8^m it was better marked ; and at 9^h 30^m, the night having deepened, I thought the Stronger Light more decided and more easily defined than at 9^h, and I think the boundary for that time may be considered reliable.

The southern glare (ice-blink?) this evening was very striking.

* Saturn had then a latitude of about 1° 20′ S., and Lon. of about 68° 39′.


R. 295
20
40

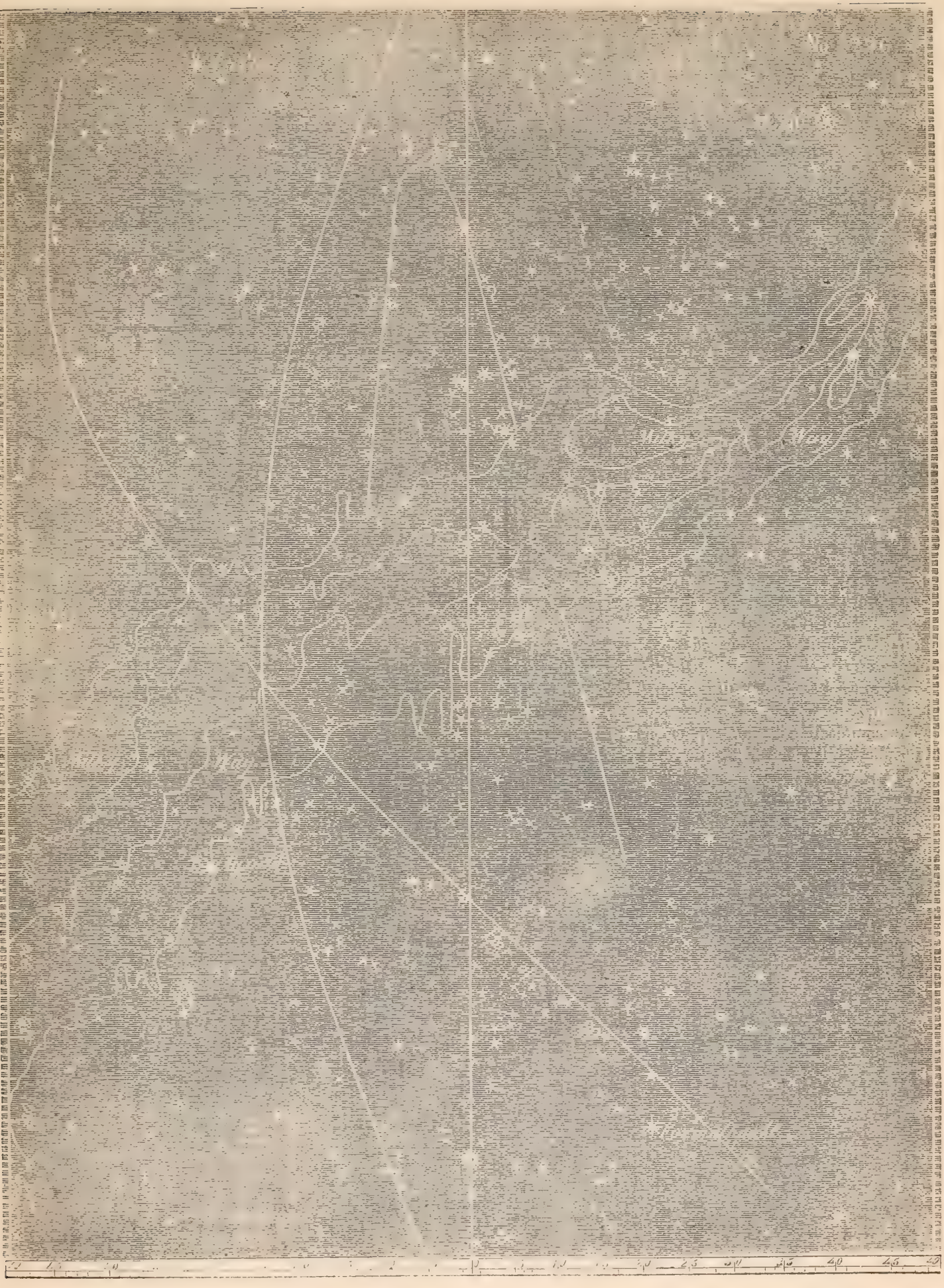
No. 296.

FEBRUARY 22d, 1855: Morning.

Lat. 53° 38′ S.: Lon. 70° 53′ W.
Sun rose at 5^h. 16^m.
Stronger and Diffuse Light at 2^h. 30^m.

Was on deck at 2 o'clock, and found the sky very favorable for observations. The Stronger Light was very bright below the Milky Way, but very dim above it; and it was very difficult to make out that portion of its boundaries. I could not get the lower boundary of the Diffuse Light at all; and the upper one was very indistinctly marked. Immediately after 2^h 30^m, a cloud began to cover the lower part of the sky; soon afterwards it put an end to observations. As my work had to be done rapidly, and the cloud prevented all attempts at verification, I cannot speak of the boundaries, as I got them, with the fullest confidence; but think they may be considered reliable.

Dawn commenced towards 3 o'clock. Thought that there were pulsations, both in boundaries and in intensity of light, but could not be certain about it.



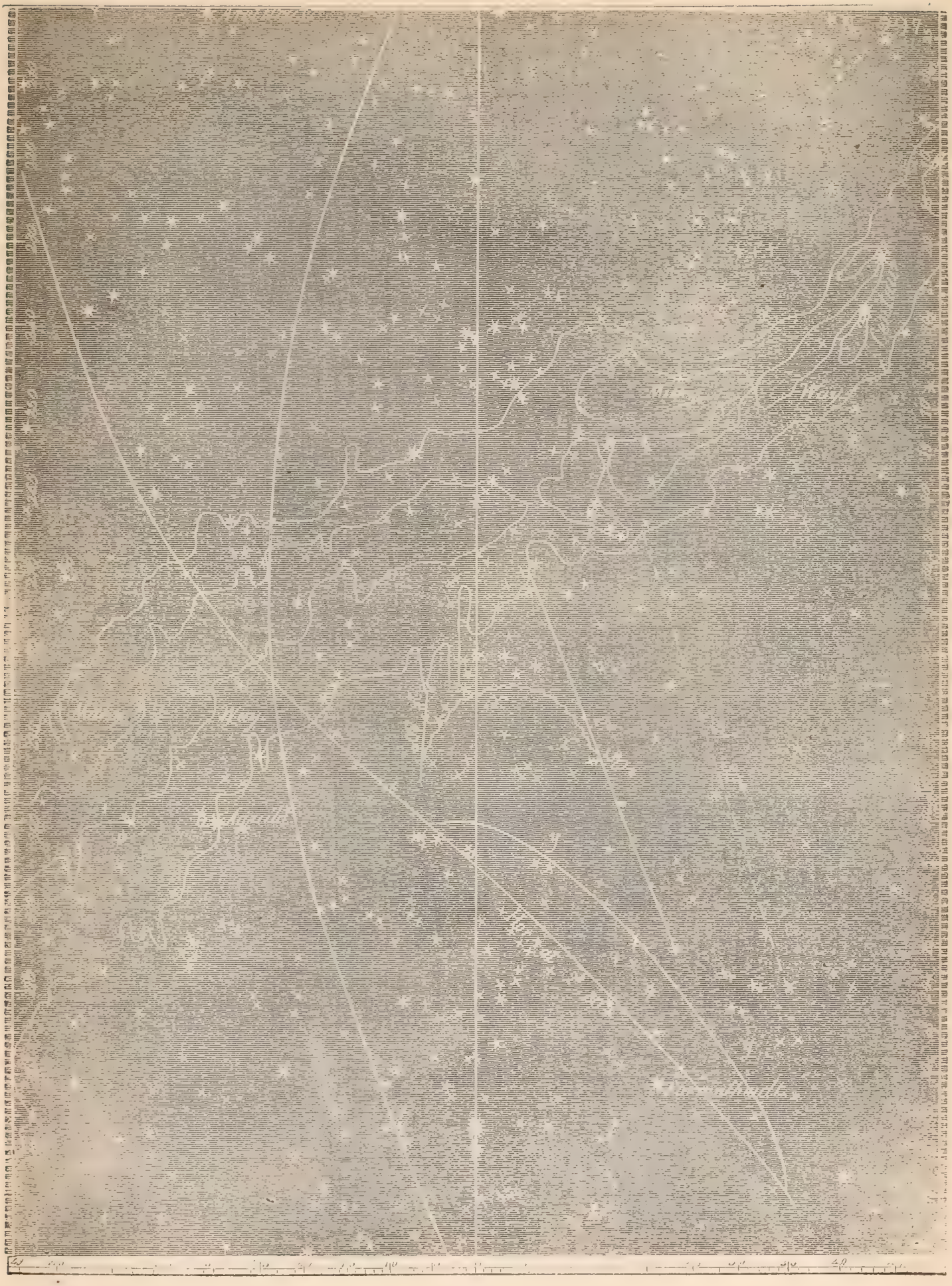
No. 297.

FEBRUARY 23d, 1855: Morning.

Lat. at 2*h*. 30*m*., 52° 28′ S.: Lon. 67° 29′ W.
Sun rose at 5*h*. 21*m*.
Stronger and Diffuse Light at 2*h*. 30*m*.

Was on deck at $2^h\ 20^m$, and found the sky perfectly clear and stars very bright, and had a very satisfactory observation. The Stronger Light was very well marked below the Milky Way, and sufficiently so above; while, at this early hour, the effulgence up to the zigzag $x\ x$ was very great. I could not see any Diffuse Light on the left; and on the right, or upper side, it was not very distinct. At $2^h\ 45^m$ the light began to stretch slowly along the horizon on the right, showing the first beginning of dawn. At $2^h\ 48^m$ the effulgence noticed as to $x\ x$ suddenly sunk to $y\ y$, and was greatly dimmed. The suddenness of the change was remarkable. The Light was now grey, having lost its warm yellowish tinge. At $2^h\ 52^m$ dawn had fully come.

The boundaries of the Stronger Light given in the chart for this morning may be considered *fully* reliable. The atmosphere was so clear, even down to the water, that stars were seen immediately on emerging from the horizon. I thought, several times, that there were pulsations, but I could not be certain about them.

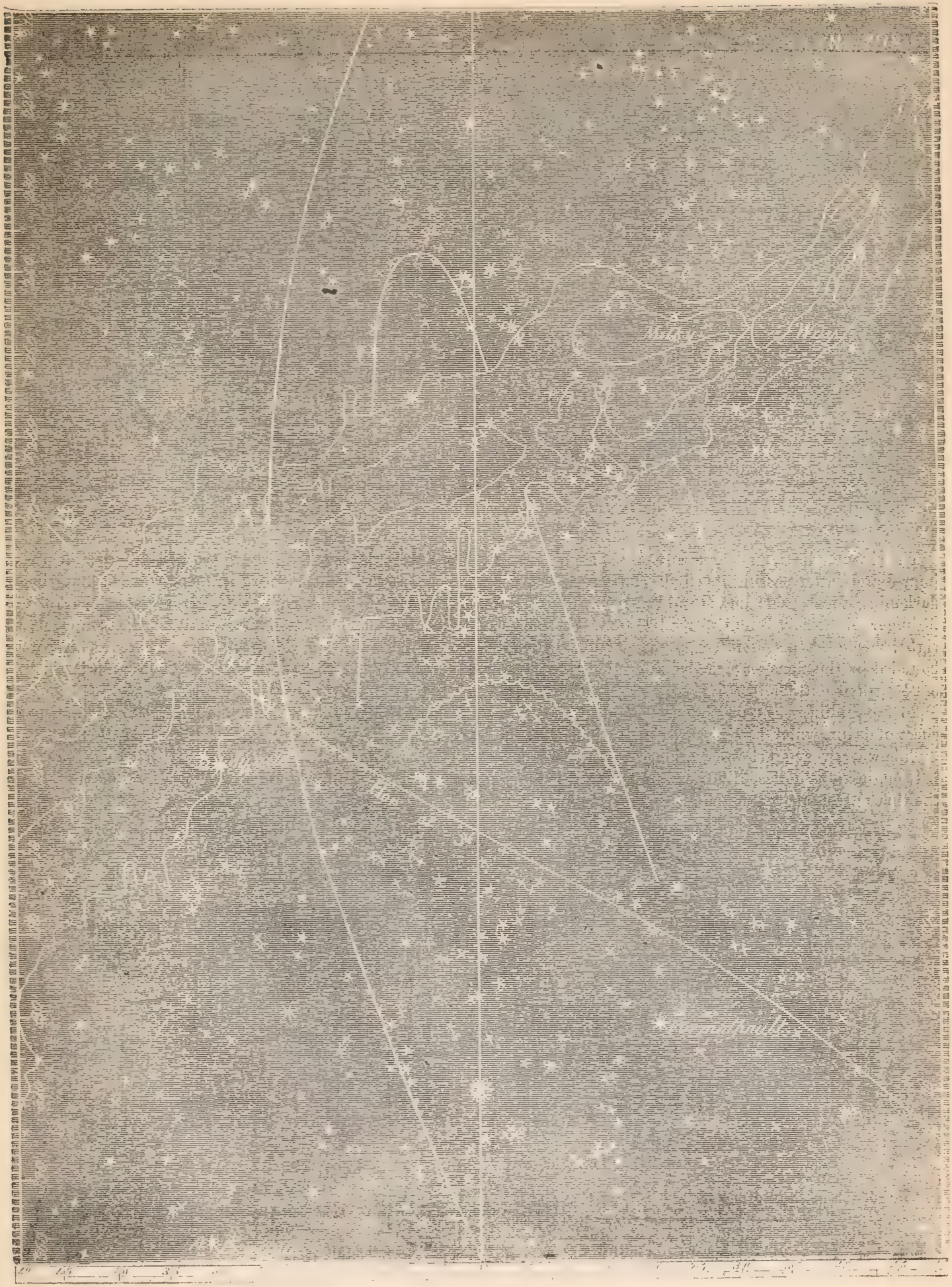


No. 298.

FEBRUARY 28th, 1855: Morning.

Lat. at 3^h., 40° 51′ S.: Lon. 57° 21′ W.
Sun rose at 5^h. 45^m.
Stronger and Diffuse Light at 3 o'clock.

Clouds since last entry (23d) until this morning. Was on deck at 2^h, and found the Zodiacal Light, at that hour, very bright; but owing to cirri continually passing, I was not able to get boundaries till 3 o'clock. I cannot speak with confidence of the lower or left-hand boundary, as the Milky Way and the clouds presented difficulties in getting it; but the upper or right-hand boundary I believe may be considered fully reliable. There was a portion of more intense light bounded by the zigzag $x\,x$. Could not get any boundaries for Diffuse on the left. Dawn came at about $3^h\ 20^m$.



No. 299.

MARCH 1st, 1855: Morning.

Lat. at 3*h*., 39° 11′ S.: Lon. 57° 12′ W.
Sun rose at 5*h*. 47½*m*.
Stronger and Diffuse Light at 3 o'clock.

The sky cloudless, and extremely favorable for observations down to the very horizon, where stars showed themselves immediately after passing its edge. I was on deck when the moon set, about $2^h\ 30^m$; but the sky was a long time in darkening afterwards; and I could not get fully reliable boundaries till 3 o'clock. Those given in the chart for the Stronger Light may be entirely relied on. Those of the Diffuse, on the left, were imperfectly marked; and, on the right, they were also not easily made out. I thought I observed pulsations in intensity. There was a portion bounded by the zigzag *x x* far brighter than the rest, and of this I made these records:* $2^h\ 58^m$ very bright; so to $3^h\ 8\frac{1}{2}^m$, when extremely bright; $3^h\ 11\frac{1}{2}^m$, just dimmed greatly; $3^h\ 19^m$, just now brightened; $3^h\ 21^m$, very bright; $3^h\ 26^m$, exceedingly so; no further change till near dawn ($3^h\ 20^m$), when it sunk down and dimmed, apparently the effect of dawn, which had come decidedly at $3^h\ 31^m$.

This was a very good observation, and the boundaries may be considered fully reliable.

It ought to be noticed that, owing to our rapid change of longitude, my watch was five or six minutes too slow; the times given above, therefore, need correction.

* Previous to 2*h*. 58*m*. I thought, sometimes, I saw changes of intensity; but was so uncertain, that I concluded it best not to record them.

Milky Way
Milky Way
Milky Way
Fomalhaut

No. 300.

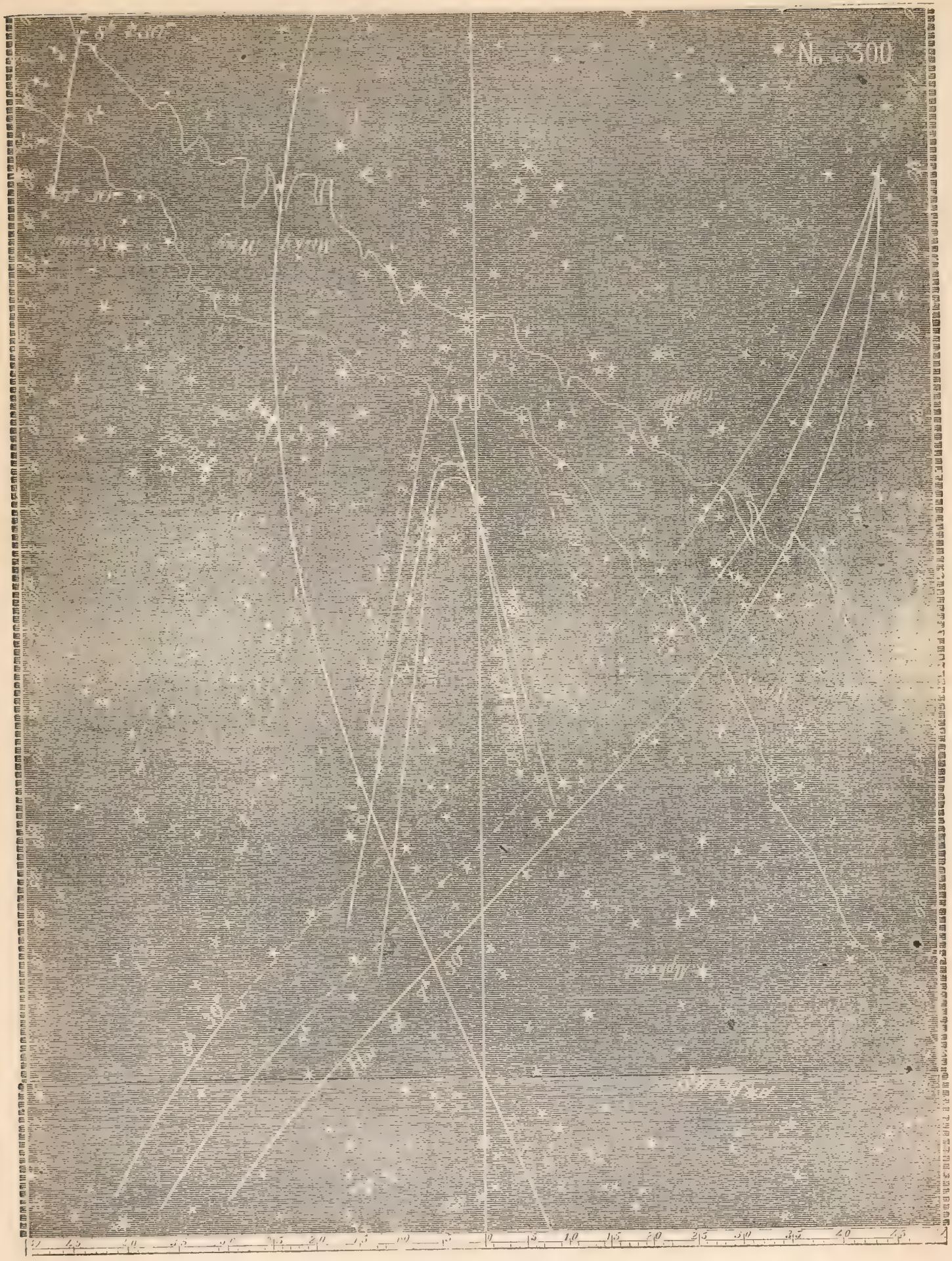
MARCH 13th, 1855: Evening.

Lat 22° 55′ S.; Lon. 43° 6′ W.

Sun set at 6*h*. 15*m*.

Stronger Light at { 7*h*. 30*m*. / 8 0 / 8 30 } Diffuse at 7*h*. 30*m*. and 8*h*.

Clouds ever since last date (1st), until this evening. Sky this evening clear, and favorable for observations. The Zodiacal Light showed itself about $7^h\ 10^m$; but I did not get reliable boundaries till $7^h\ 30^m$. At $7^h\ 45^m$, it was very bright. At $8^h\ 45^m$, the right-hand boundary of the Stronger Light appeared pretty clearly to have slid over (as in the chart), similarly to that on the left; but I will not speak confidently of this, as it had then sunk considerably towards the horizon. At $8^h\ 30^m$, the Stronger and Diffuse Light seemed to have merged considerably into one; and it was difficult to get any boundaries for the former. I have given its upper boundary as it seemed to me for that hour; the lower one appeared to be as at 8^h. At $9^h\ 30^m$, the Zodiacal Light was still visible (though dim) below the Milky Way, and seemed to show itself above this also; but it did not give any reliable boundaries.

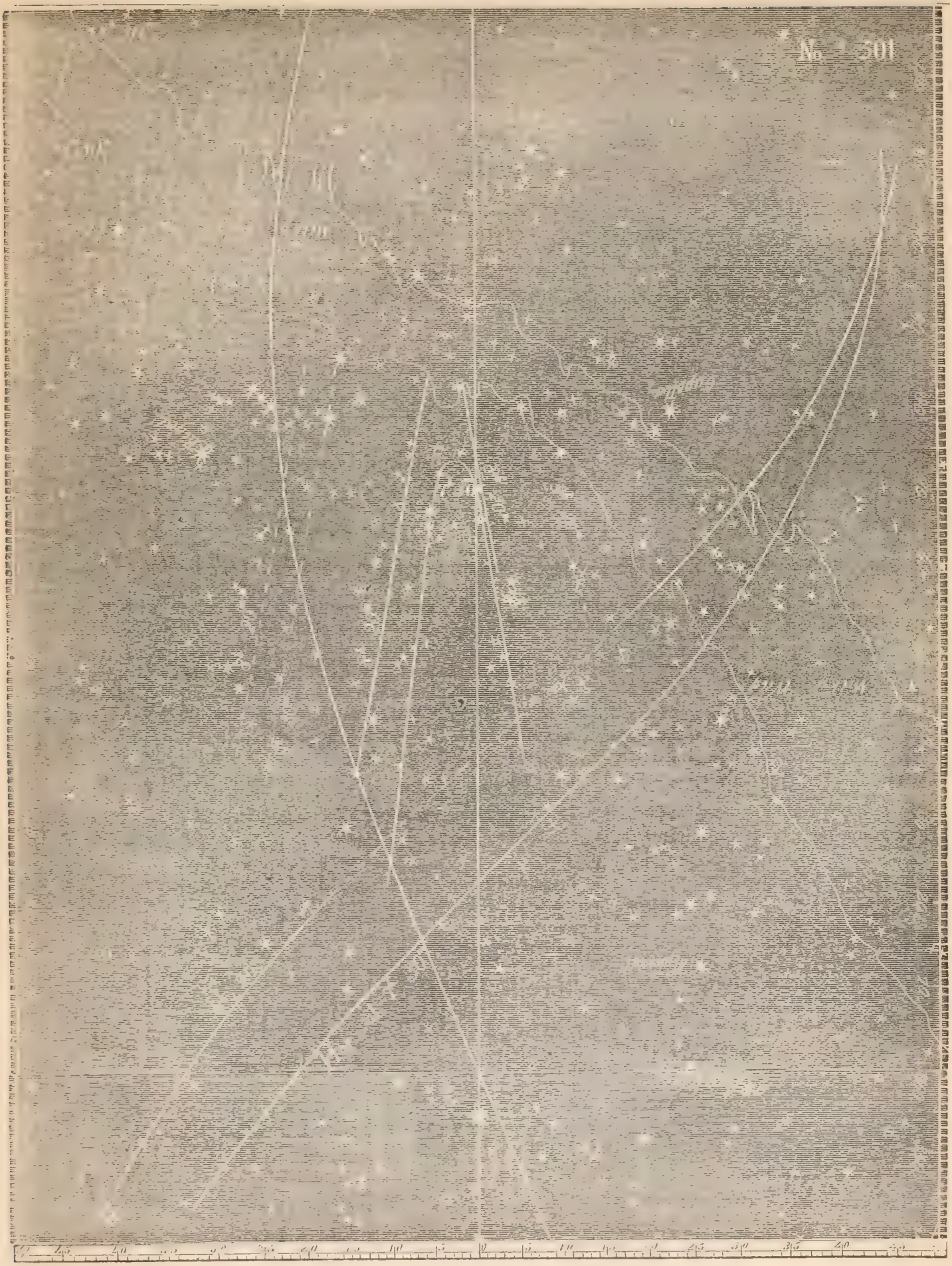

No. 300

No. 301.

MARCH 15th, 1855: Evening.

Lat 22° 55′ S.: Lon 43° 6′ W.
Sun set at 6*h*. 12*m*.
Stronger and Diffuse Light at 7*h*. 30*m*. and 8*h*. 20*m*.

Clouds last evening. The sky this evening bright and clear, except a dark cloud in the west, which, gradually ascending, finally put a stop to observations. Was able, however, to get reliable boundaries for the Diffuse, and also on the upper or left side of the Stronger Light. Those for the lower side of the latter were interfered with by the cloud, and I cannot speak of them so confidently.


No. 301

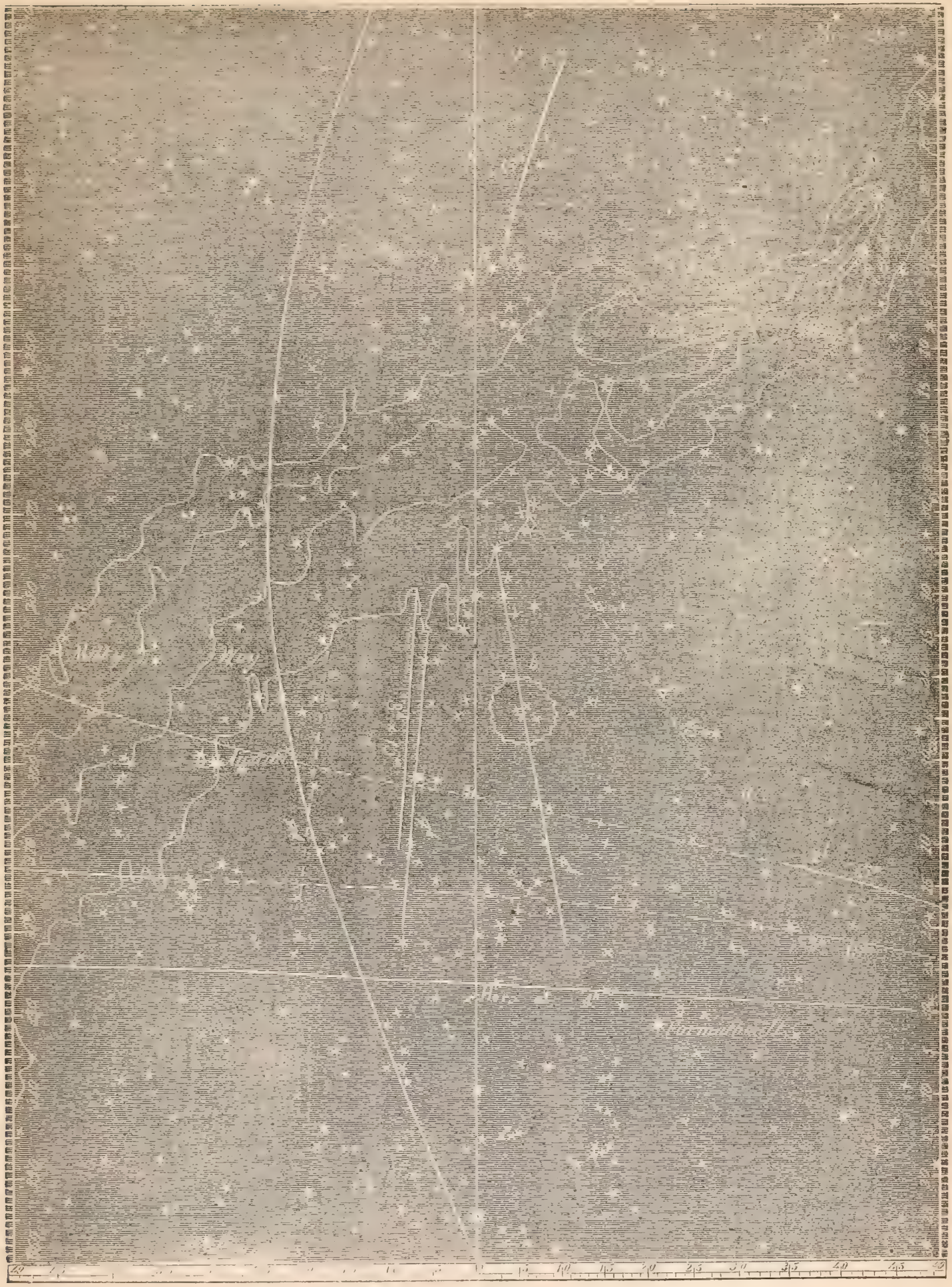
No. 302.

MARCH 16th, 1855: Morning.

Lat. 22° 55′ S.: Lon. 43° 6′ W.
Sun rose at 6*h*. 6*m*.
Stronger Light at 3*h*. 15*m* and 4*h*.: Diffuse at 2*h*. 15*m*. and 4*h*.

A beautiful clear morning, and everything favorable for observations. I was on deck immediately after 2 o'clock, and found the Zodiacal Light very strongly marked; but, from the interference of the Milky Way, giving a boundary only on the right hand or southern side. This one was well marked (as at *a a* in the chart), with a stronger patch of light at *b*. But, although I then took the former to be the Stronger Light, it was doubtless only of the Diffuse Light; for, at $3^h\ 15^m$ and 4^h, the boundaries of the Stronger Light were decidedly as those given in the chart, while *a a* now as decidedly was the limit of the Diffuse Light. Indeed, at the earliest of the morning, as well as at the latest of the evening observations, the Stronger and Diffuse Lights can scarcely (if at all) be distinguished from each other—the former being dim, and the latter stronger than at the other times.

The moon rose about 4^h. Jupiter's light is now getting to be troublesome in the morning observations.



No. 303.

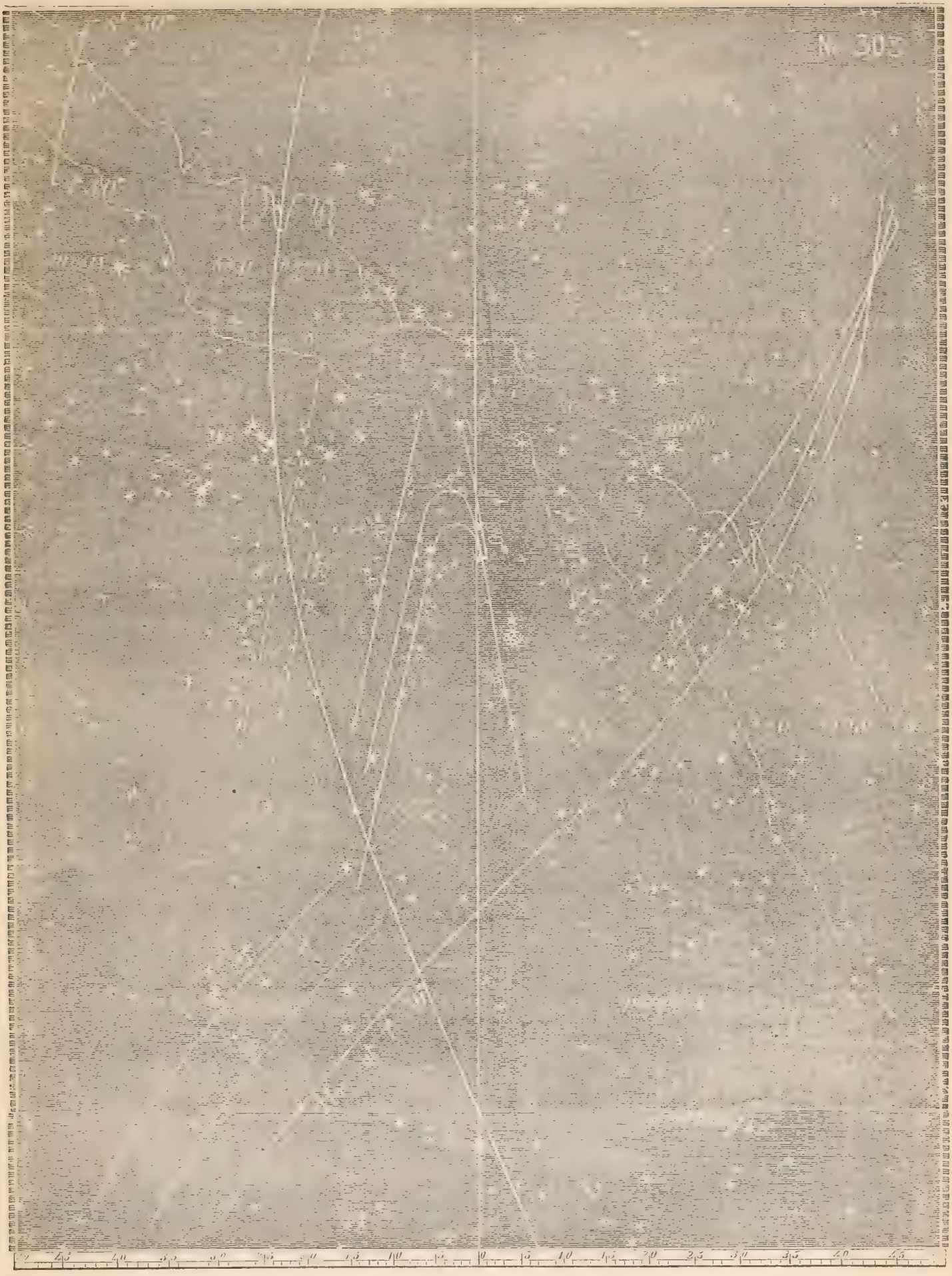
MARCH 16th, 1855: Evening.

Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun set at 6*h*. 12*m*

Stronger and Diffuse Light at { 7*h*. 30*m*. / 8 0 / 8 30

Sky very favorable for observations, and, at $7^h\ 30^m$, I was able to get boundaries, which may be considered fully reliable. At 8^h the sky was still favorable, and the Zodiacal Light was still bright; but, soon after this, the Light began to grow dim; and, at $8^h\ 30^m$, it had dimmed so much, that it was with some difficulty I was able to get boundaries. Those given in the chart, however, I believe may be relied on.


N 30°

No. 304.

MARCH 17th, 1855: Morning.

Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun rose at 6*h*. 6*m*.

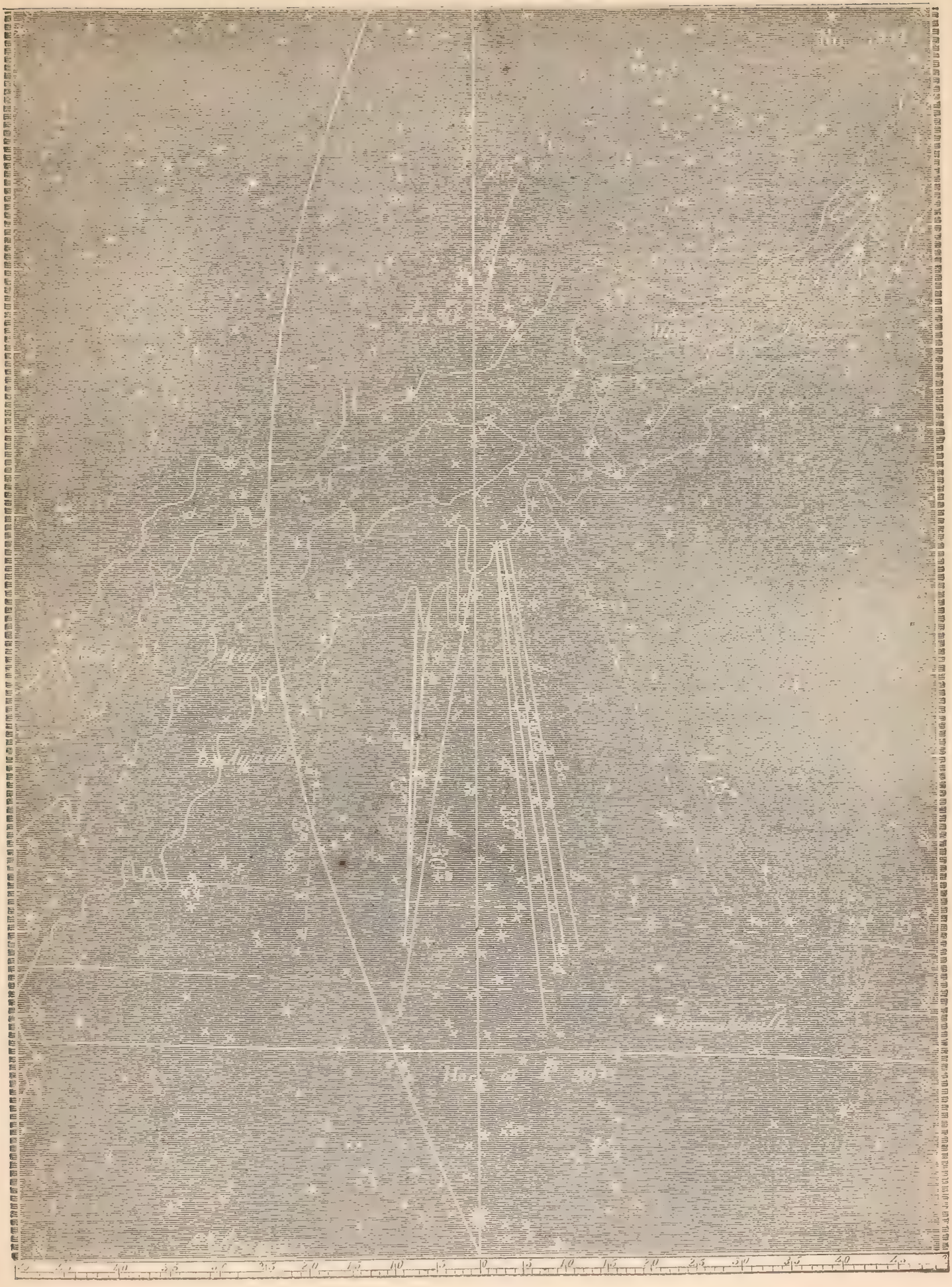
Stronger Light at { 3*h*. 15*m*. / 4 0 / 4 30 } Diffuse at 3*h*. 15*m*., &c.

Sky very favorable, and I watched all the changes of the Zodiacal Light from 3 o'clock till dawn. At 3ʰ the Light was yet dim, but gave reliable boundaries: though, on the right, I was puzzled somewhat in getting them, as they seemed *to change*. After a while I thought, suddenly, that the Light had dimmed considerably, and then came to the conclusion that there were pulsations, not only in intensity of the whole, but also in the boundaries at the right. Of these I began to take note, sometimes fully satisfied that there were pulsations, sometimes doubting and giving up annotations of that kind. The following are my notes:

h. *m*.
* * *
At 3 20, bright, and at *b*.
3 21½, dimming.
3 23, dim, and at *a*.
3 25, brightening.
3 26½, bright, and at *b*.
3 29, still so.
* * *

h. *m*.
(An interval of doubting.)
* * *
At 3 40, *obviously* dim, and at *a*.
3 42, brightening.
3 43, *decidedly* brighter, and at *b*.
3 48, very bright.
4 6, still so.

After 4ʰ 6ᵐ, I could see nothing like pulsations. The brightness had now got to be very great, and I saw no changes, till, by and by, it began to fade away, or rather to be merged in the dawn, which had come decidedly at 4ʰ 48ᵐ.



No. 305.

MARCH 17th, 1855: EVENING.

Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun set at 6*h*. 11*m*.

Stronger Light at { 7*h*. 30*m*. / 8 0 / 8 30 } Diffuse at 7*h*. 30*m*. and 8*h*.

The sky clear, and night very favorable for observations. Watched most carefully every change of the Zodiacal Light; for these changes were remarkably distinct, and, owing to the rapid change of angularity between the ecliptic and horizon, were very rapid. The Stronger Light was well marked at $7^h\ 20^m$, but I could not get reliable boundaries till ten minutes afterwards. I thought sometimes that there were pulsations, and made the following record:

h. *m*.	*h*. *m*.
At 7 40, very bright.	At 7 51, brightened, and at *b*.
7 43, still bright, and at *b*.	7 52, very bright.
7 45, dim, and at *a*.	

After $7^h\ 52^m$ it grew dimmer, and at $8^h\ 10^m$ had dimmed considerably. At $8^h\ 30^m$ it was still distinctly marked in the sky, but the Stronger passed so gradually into the Diffuse, that it was difficult to say where its boundaries were. At 9^h the Zodiacal Light was still clearly marked on the sky, but no reliable boundaries could be got.

No. 306.

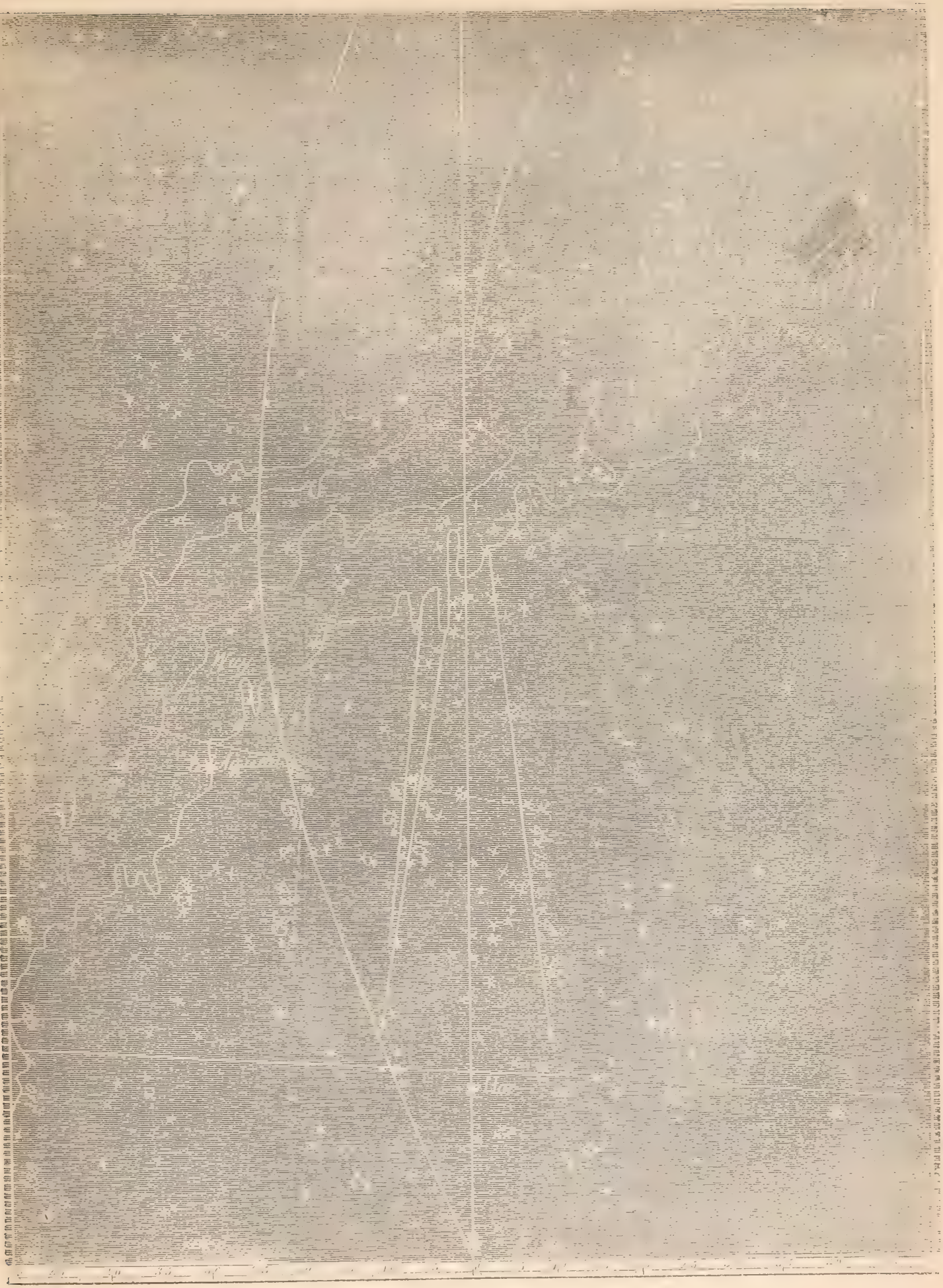
MARCH 20th, 1855 (18th was Sunday): Morning.

Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun rose at 6*h*. 7*m*.

Stronger Light at 4*h*. 15*m*. and 4*h*. 30*m*.: Diffuse { 2*h*. 0*m*. / 4 15 / 4 30

Yesterday morning was cloudy, so also last evening. This a. m. went on deck at 2 o'clock, to examine carefully with reference to the light seen in the morning at our farthest southern latitude. Found at that hour a decided Zodiacal Light impressed on the sky, and with the limits on the right at α α. This Light was very decided, and also its boundary. On the left it increased gradually in strength towards α and β Capricorni; but, on that side, I could not get any reliable boundaries, neither could I make out any decided boundaries for the Stronger Light, it passed so gradually into the Diffuse. Was up again at 3h 30m; but clouds interfered till 4h 15m, when I had an excellent sky for observations; the Stronger Light was at this time very strong, with boundaries well marked, and fully reliable. In the chart is a remarkable change of the left boundary of the Stronger Light, between 4h 15m and 4h 30m: so singular and remarkably great as to be at first sight quite doubtful (see chart). But there was a similar change yesterday morning; and to-day I gave particular attention to it, and, as the boundaries both at 4h 15m and 4h 30m were very decided, I think there cannot be any doubt on the subject. Of the other boundaries there was not any change in this period. At 4h 30m, the Stronger Light was extremely brilliant; but this effulgence, instead of being only near the horizon, as formerly, extended up in a conical form quite to the upper extremity of the Light, tapering off, however, in intensity as it ascended.



No. 307.

MARCH 21.4, 1855: Morning.

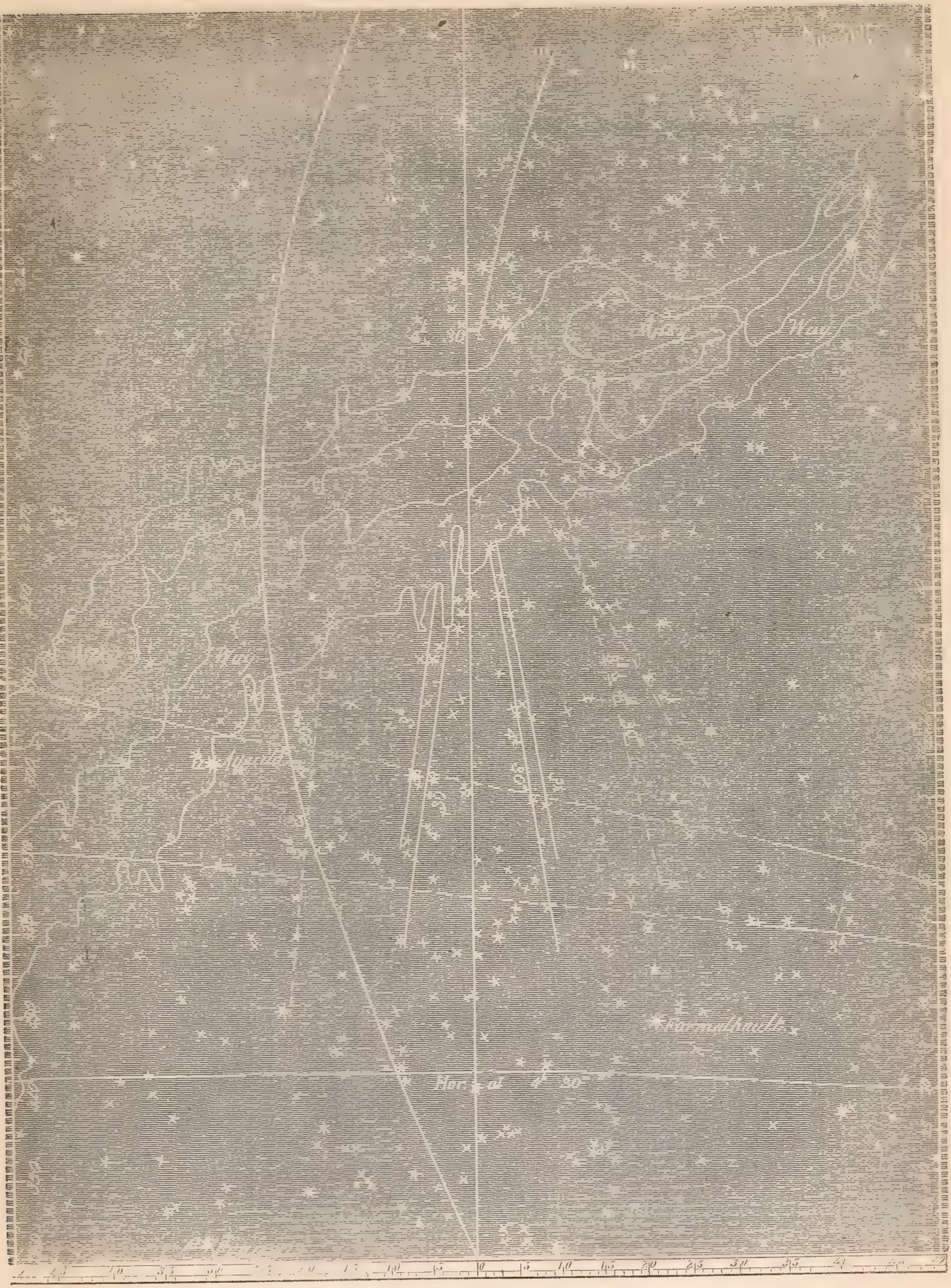
Lat. 22° 55′ S.: Lon. 13° 6′ W.

Sun rose 6*h*. 7*m*.

Stronger Light at 3*h*. 0*m*. and 4*h*. 30*m*.: Diffuse at { 2*h*. 0*m*. / 3 0 / 4 30

Sun's lon. 0° 19′.

Clouds last evening. Was on deck at 2 o'clock. The Zodiacal Light was very distinct, but was only a whitish-yellow patch in the angle between the Milky Way and horizon, thinning off gradually till it seemed to be lost at the line *a a*, the boundary there being very indistinct. Again on deck at 3ʰ, when the Zodiacal Light was very distinct; all the boundaries very well marked, especially those on the left or north. The sky, so far, was very favorable for observations: but at 4ʰ, clouds interfered; these cleared away by 4ʰ 30ᵐ, leaving all things again quite favorable for observations; and I had reliable boundaries, which I took with the greatest care. The Light was then very strong. At 4ʰ 43ᵐ it began to spread, and in a few minutes dawn had decidedly come.



No. 308.

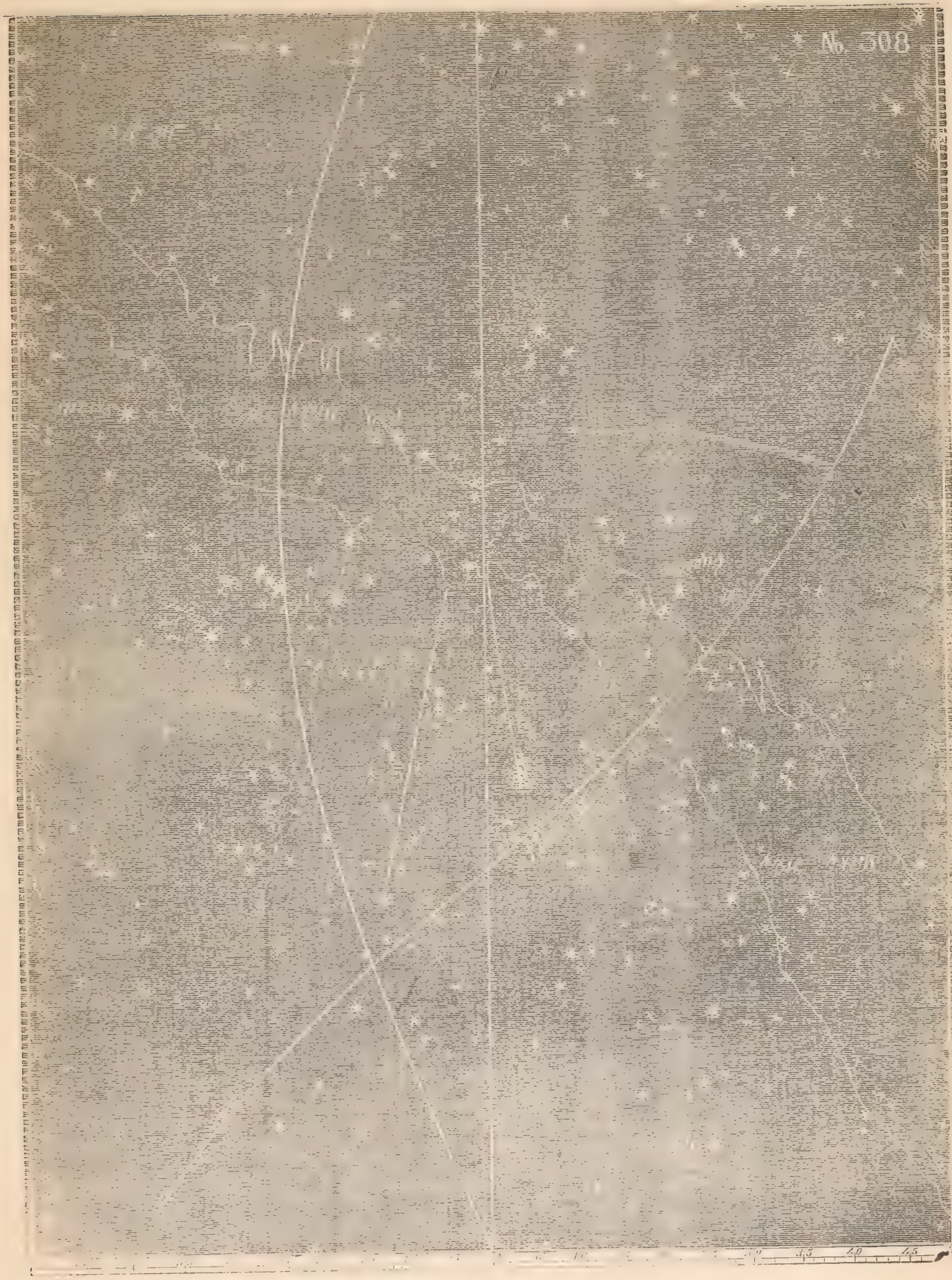
MARCH 21st, 1855: EVENING

Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun set at 6*h.* 7½*m.*

Stronger Light at 8*h.* 3*0m.*: Diffuse at 8*h.* 30*m.* and 9*h.* 0*m.*

The moon did not set till near 8^h 30^m, when I was able to get an observation: sky clear and brilliant, but the Stronger Zodiacal Light already so much dimmed, and so little of it left, as not to give very good outlines below: the upper part is also not fully reliable. The boundary of the Diffuse Light given may be relied on; the lower one of the latter could not be had. At 9^h, the Light was still distinct, but dim, and would give no reliable boundaries for the Stronger Light. The Diffuse was the same as at 8^h 30^m.


No. 303
3.5
4.0
4.5

No. 309.

MARCH 23d, 1855: Morning.

Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun rose 6*h*. 9*m*.

Stronger Light at { 3*h*. 0*m*. / 4 0 / 4 30 } Diffuse at 3 and 4 o'clock.

Clouds yesterday morning. Sky this a. m. very fine for observations. At 3ʰ, the Zodiacal Light, though distinct, was rather dim, but gave reliable boundaries; though, on the right, or southward, it was difficult to get those of the Stronger Light, since it passed so gradually into the Diffuse. So, also, afterwards. While looking at it, I thought that at about 3ʰ 20ᵐ it suddenly brightened. Was on deck again at 4ʰ: sky good, and Light very bright. But at 4ʰ 22ᵐ, it seemed to become much dimmed, and to contract its limits: at 4ʰ 28ᵐ it was again very bright. Against these last two changes, I entered on my record, made at the time, "no doubt of this." At 4ʰ 30ᵐ it was extremely bright.

Milky Way
Milky Way
Milky Way
Milky Way
Hor. ad

No. 310.

MARCH 24th, 1855: MORNING.

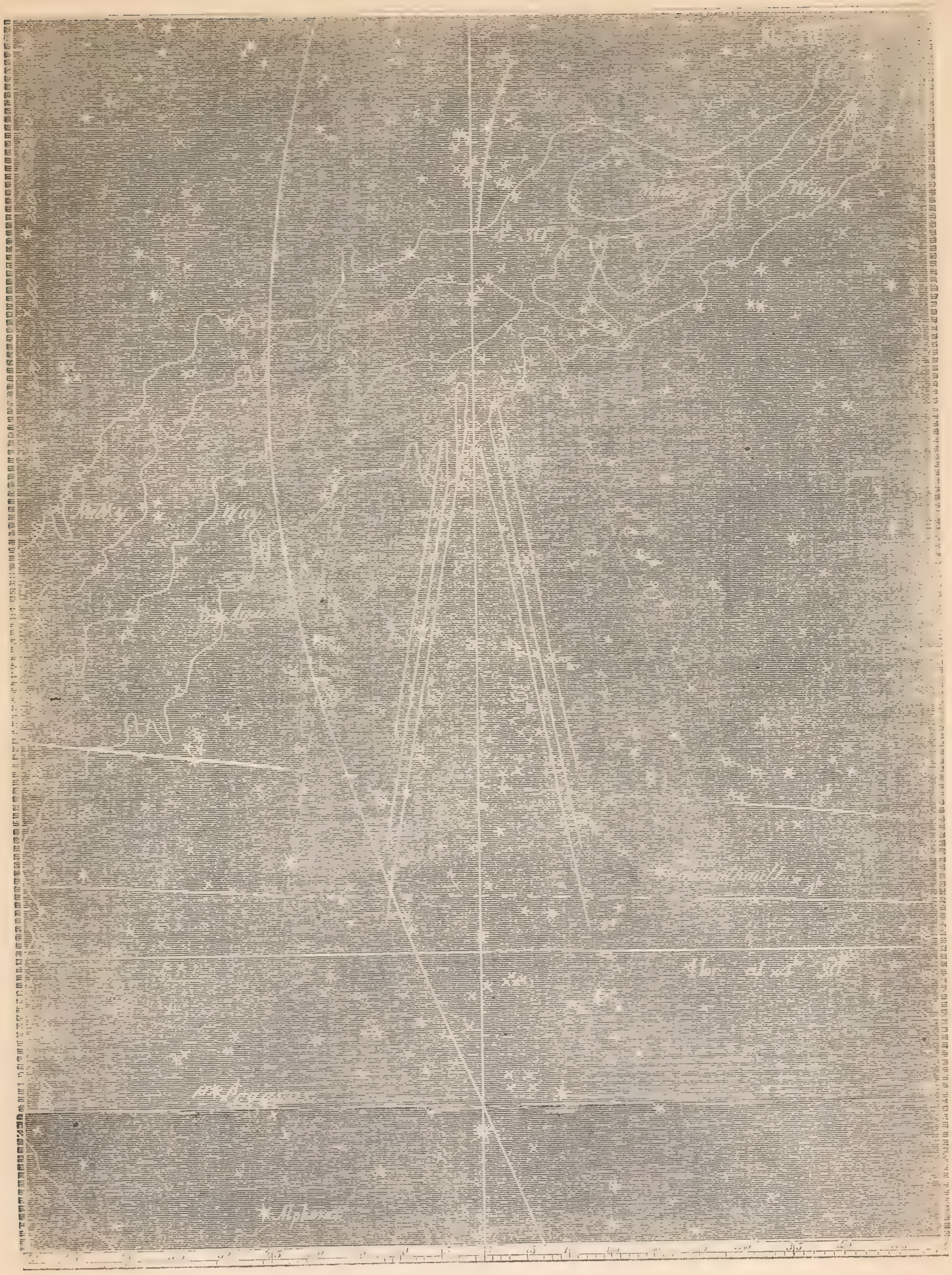
Lat. 22° 55′ S.: Lon. 43° 6′ W.

Sun rose at $6h.\ 8\frac{1}{2}m.$

Stronger and Diffuse Light at { 3h. 0m. / 4 0 / 4 30

Was on deck at 3 a. m., and found the sky very favorable for observations. The Zodiacal Light was dim, but gave good outlines. About $3^h\ 10^m$, the Stronger Light had increased considerably, with a more effulgent portion at its central part, along the line of the ecliptic.

Again on deck at 4^h; and as the morning was in every respect remarkably favorable, except the radiance of Jupiter, I watched carefully and long to see whether there would be pulsations. The Stronger Light was very brilliant, and continued so, till at $4^h\ 13^m$, I noticed that it had suddenly dimmed very much, with its lateral borders contracted. At $4^h\ 20^m$, it had spread again, and had brightened once more. At $4^h\ 21^m$, it was very bright. I thought at the time that there could be no uncertainty about these changes. I did not notice any others. Dawn about $4^h\ 48^m$.



No. 311.

MARCH 26th, 1855 (25th was Sunday): MORNING.

Lat. at 3*h*. 30*m*., 22° 8′ S.: Lon. 39° 26′ W.

Sun rose at 6*h*. 9*m*.

Stronger and Diffuse Light at 3*h*. 20*m*.

Was on deck at 3 o'clock this a. m.; but clouds prevented my getting outlines till $3^h\ 20^m$, at which time the sky was very favorable for observations. Soon after this, clouds interposed: continued cloudy during the remainder of the morning.

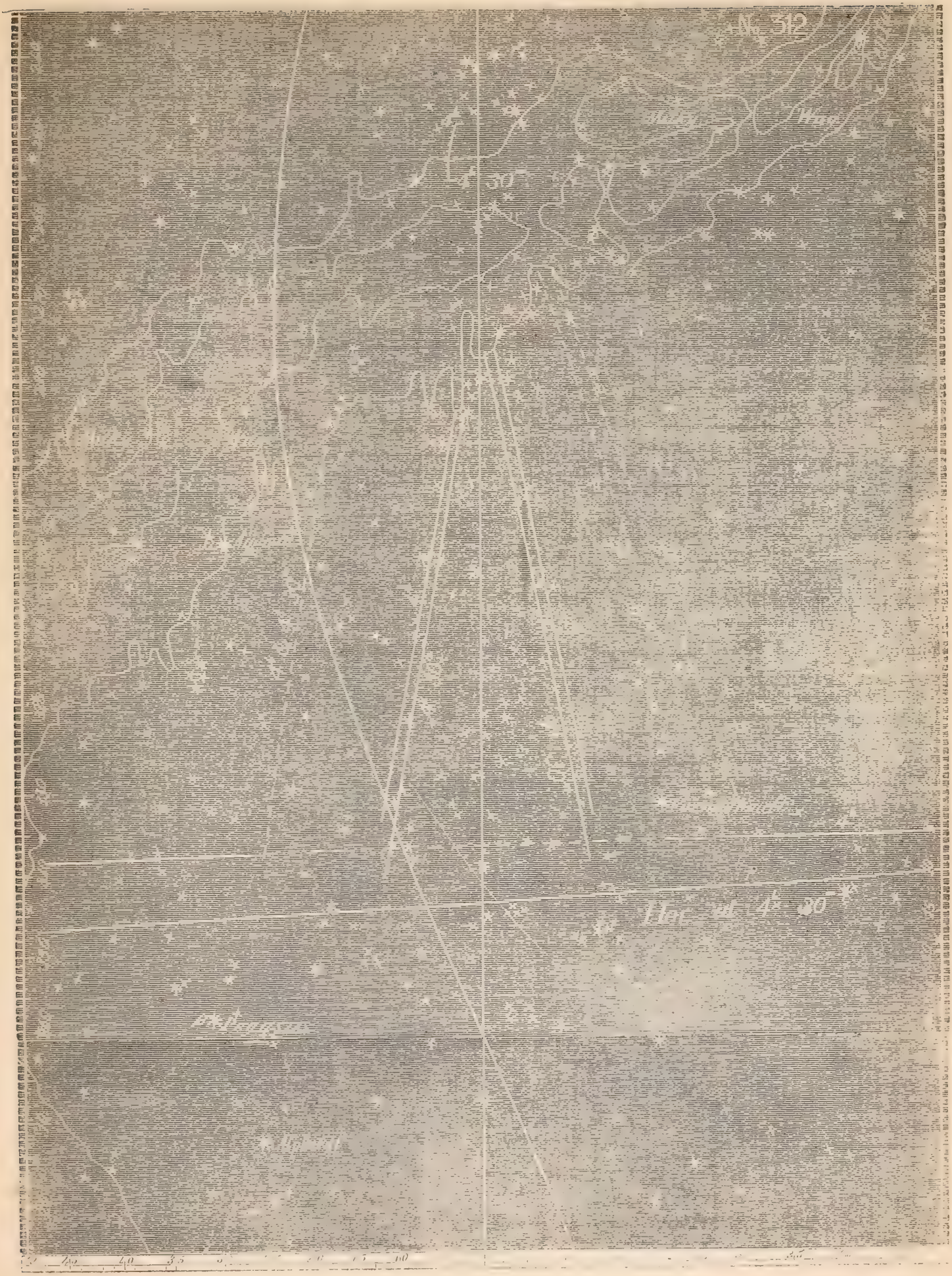
Milky Way
Milky Way
Aquila
Hor
Scorpius

No. 312.

MARCH 28th, 1855: Morning.

Lat. at 4*h*, 19° 32′ S.: Lon. 36° 13′ W.
Sun rose at 6*h*. 9*m*.
Stronger and Diffuse Light at 4*h*. 0*m*. and 4*h*. 30*m*

Cloudy yesterday morning. Clouds also this morning, till near 4 o'clock, when the sky became very favorable for observations. I was able, at this time, to get boundaries with great precision; and so, also, at $4^h\ 30^m$. At $4^h\ 40^m$, there seemed to be a sudden dimming of the Stronger Light. Dawn at $4^h\ 45^m$.


N. 32
30°
Ecliptic
Aldebaran
Pleiades
Hyades
Orion
Sirius
Procyon
Regulus
Spica
Arcturus
Antares
Vega
Altair
Fomalhaut
Deneb
Capella
Pollux
Castor
Gemini
Taurus
Perseus
Andromeda
Pegasus
Aquarius
Capricornus
Sagittarius
Scorpio
Libra
Virgo
Leo
Cancer
Auriga
Ursa Major
Ursa Minor
Draco
Cassiopeia
Cepheus
Lyra
Aquila
Cygnus
Ophiuchus
Hercules
Corona
Bootes
Serpens
Hydra
Crater
Corvus
Centaurus
Lupus
Ara
Scorpius
Norma
Triangulum
Aries
Cetus
Eridanus
Lepus
Canis Major
Canis Minor
Hydra
Argo
Crux
Musca
Apus
Octans
Pavo
Grus
Piscis Australis
Piscis Volans
Phoenix
Eridanus
Fornax
Sculptor
Cetus
Aquarius
Pisces
Aries
Taurus
Gemini
Cancer
Leo
Virgo
Libra
Scorpio
Sagittarius
Capricorn

No. 313.

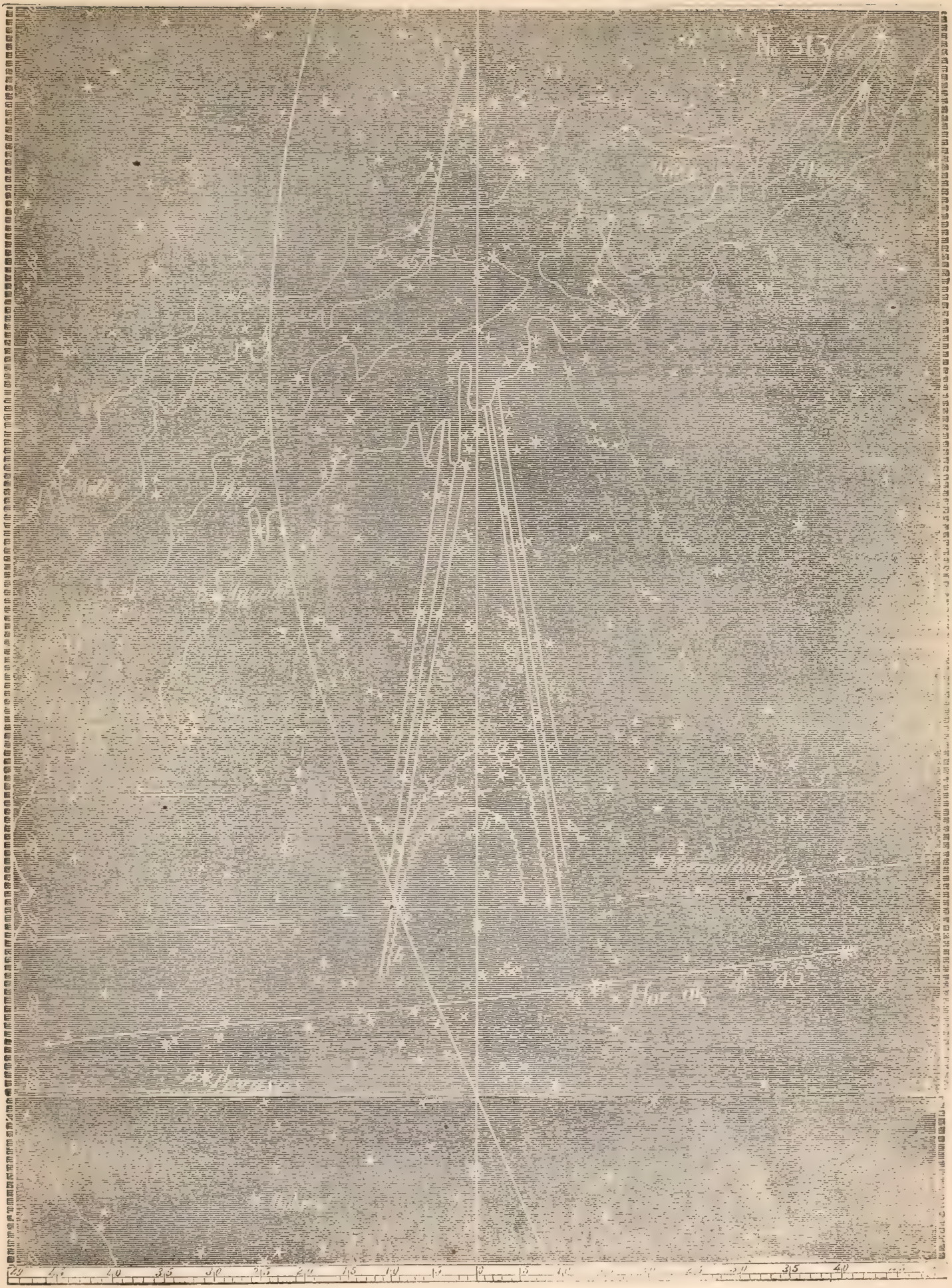
MARCH 29th, 1855: MORNING.

Lat. at 4^h., 17° 24′ S.: Lon. 35° 10′ W.

Sun rose at 6^h. 9^m.

Stronger Light at { 3^h. 0^m. / 4 0 / 4 30 } Diffuse 3^h. and 4^h.

Was on deck at 3 o'clock, and found the sky clear and very good for observations. The left or northern boundaries of the Zodiacal Light were well marked: on the right hand, or southward, the Stronger Light passed more gradually into the Diffuse; but still it gave very good boundaries. All those given at 3^h, 4^h, and 4^h 30^m, in the chart, appeared to me to be fully reliable. At 4^h, found the sky still very favorable; the Stronger Light bright and cone-shaped. Thought I saw pulsations; but was too uncertain to record them, till 4^h 16^m, when there seemed to be a sudden and great dimming of the Stronger Light, and it then sunk down to the zigzag *a*. At 4^h 20^m, it had contracted to *b b*, leaving of the Stronger Light only the small patch within that zigzag, greatly dimmed from what the Light was at 4^h. My record then goes on: "4^h 25^m, still dim; about 4^h 26^m, brighter; 4^h $27\frac{1}{2}^m$, dimmed; 4^h $29\frac{1}{2}^m$, brighter, and has shot up once more into the cone shape; 4^h 38^m, quite bright, still cone shaped, but brightest within the zigzag *a*; 4^h 43^m, very bright within the zigzag *a*; 4^h 45^m, is breaking bounds and spreading at the horizon; 4^h 48^m, dawn has come."

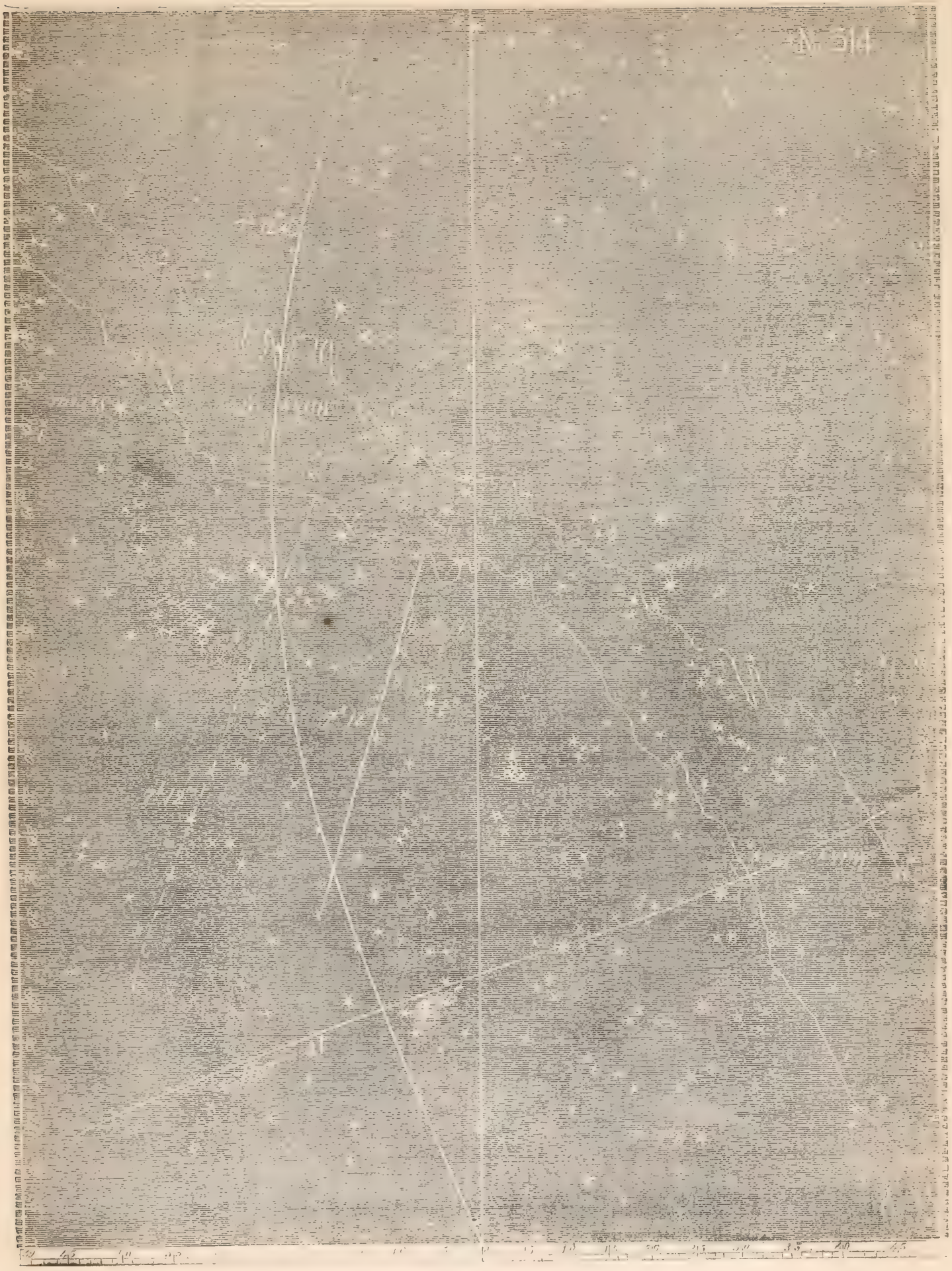


No. 314.

APRIL 4th, 1855: Evening.

Lat. at 8*h*., 1° 37′ N.: Lon. 37° 37′ W.
Sun set at 6*h*. 33½*m*.
Stronger and Diffuse Light at 7*h*. 12*m*.

Clouds since last date (29th ult.) until this evening. Sky now sufficiently clear, at $7^h\ 12^m$, to allow me to get the southern boundaries of the Zodiacal Light, both of the Stronger and Diffuse. The northern boundaries were covered by clouds. The eastern horizon was covered by clouds; but the moon, now risen, soon broke through them, and put a stop to observations for the evening.


N. 514

No. 315.

APRIL 9th, 1855: EVENING.

Lat. at 8*h*., 11° 12′ N.: Lon. 45° 51′ W.

Sun set at 6*h*. 7*m*.

Stronger Light at { 7*h*. 30*m*. / 8 0 / 8 45 / 9 50 } Diffuse 8*h*. to 9*h*. 50*m*.

Clouds since last date (4th) until this evening. Sky, to-night, very fine for observations, except a few passing clouds, which occasioned, however, no material interruption. The Zodiacal Light showed itself at $7^h\ 12^m$, but I was not able to rely upon its boundaries till $7^h\ 30^m$. Its course across the Milky Way is now quite marked and decided, in the case of even the Diffuse Light; but the upper extremities of both are not well defined. Those (the upper) of the Stronger Light became better defined as the night advanced: of the Diffuse Light, not so well. At $9^h\ 50^m$, the Light was distinctly marked, though now much dimmed, and its boundaries barely reliable.

No. 315

No. 316.

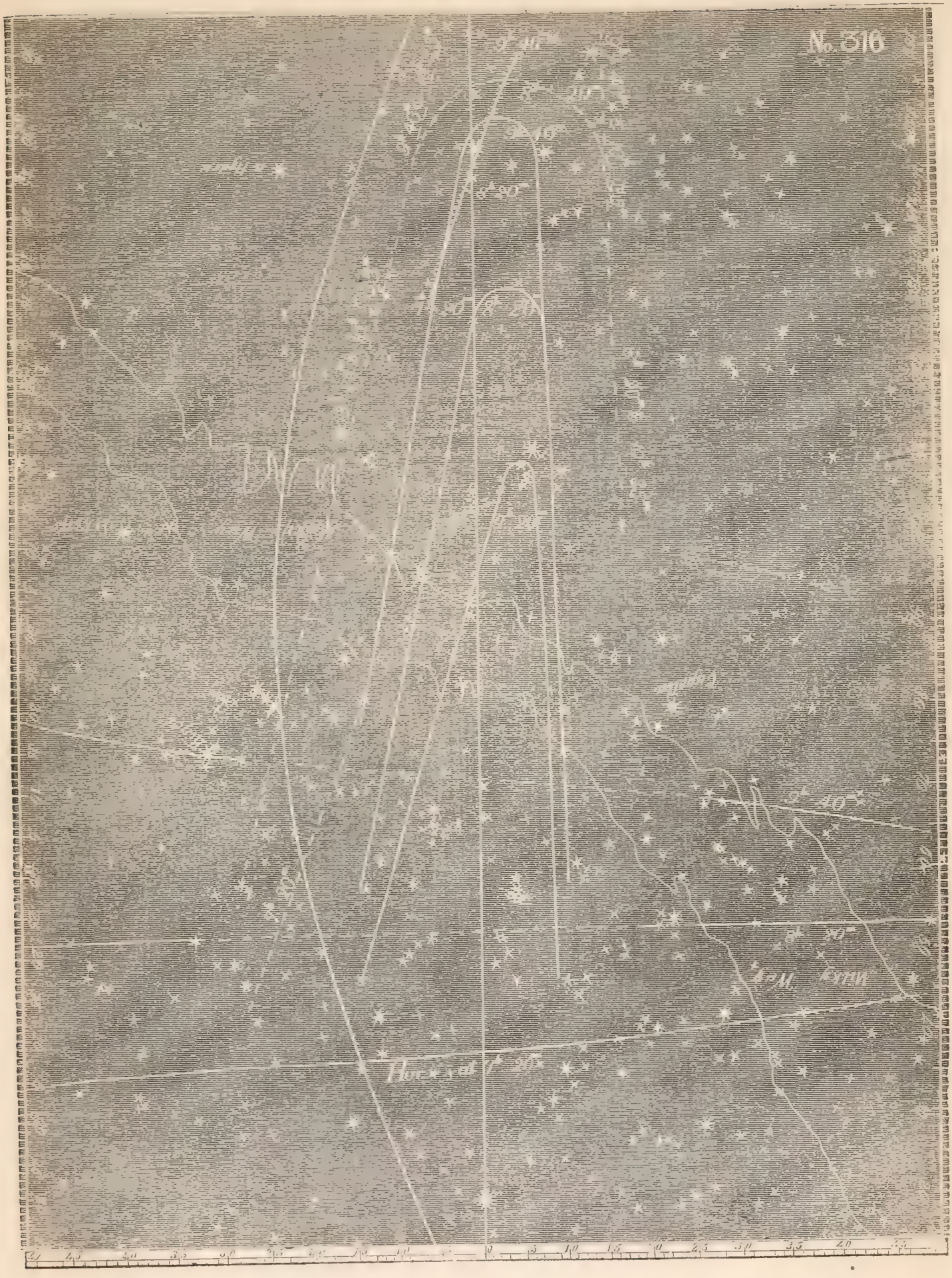
APRIL 10th, 1855: EVENING.

Lat. at *h.*, 13° 5′ N.: Lon. 47° 20′ W

Sun set at $6h.\ 8\frac{1}{2}m.$

Stronger Light at { 7*h.* 20*m.* / 8 20 / 9 40 } Diffuse at 7*h.* 20*m.*, 8*h.* 20*m.*, and 10*h.* 35*m.*

Night very favorable for observations. Had an observation as early as $7^h\ 20^m$. Soon after this, the Stronger Light became very bright. I observed carefully to see whether there were pulsations; but the brilliancy of Venus, now in the way, made such observations difficult. I could not see any thing like pulsations. Could not make out reliably the right-hand boundary of the Diffuse Light at $7^h\ 20^m$, on account of the Milky Way. At $9^h\ 40^m$ the Light was well marked; could not make out the upper end of the Diffuse. At $10\ 35^m$ the Light still quite distinct, but now could not make out the boundaries of the Stronger Light. It was merged in the Diffuse.


No. 316

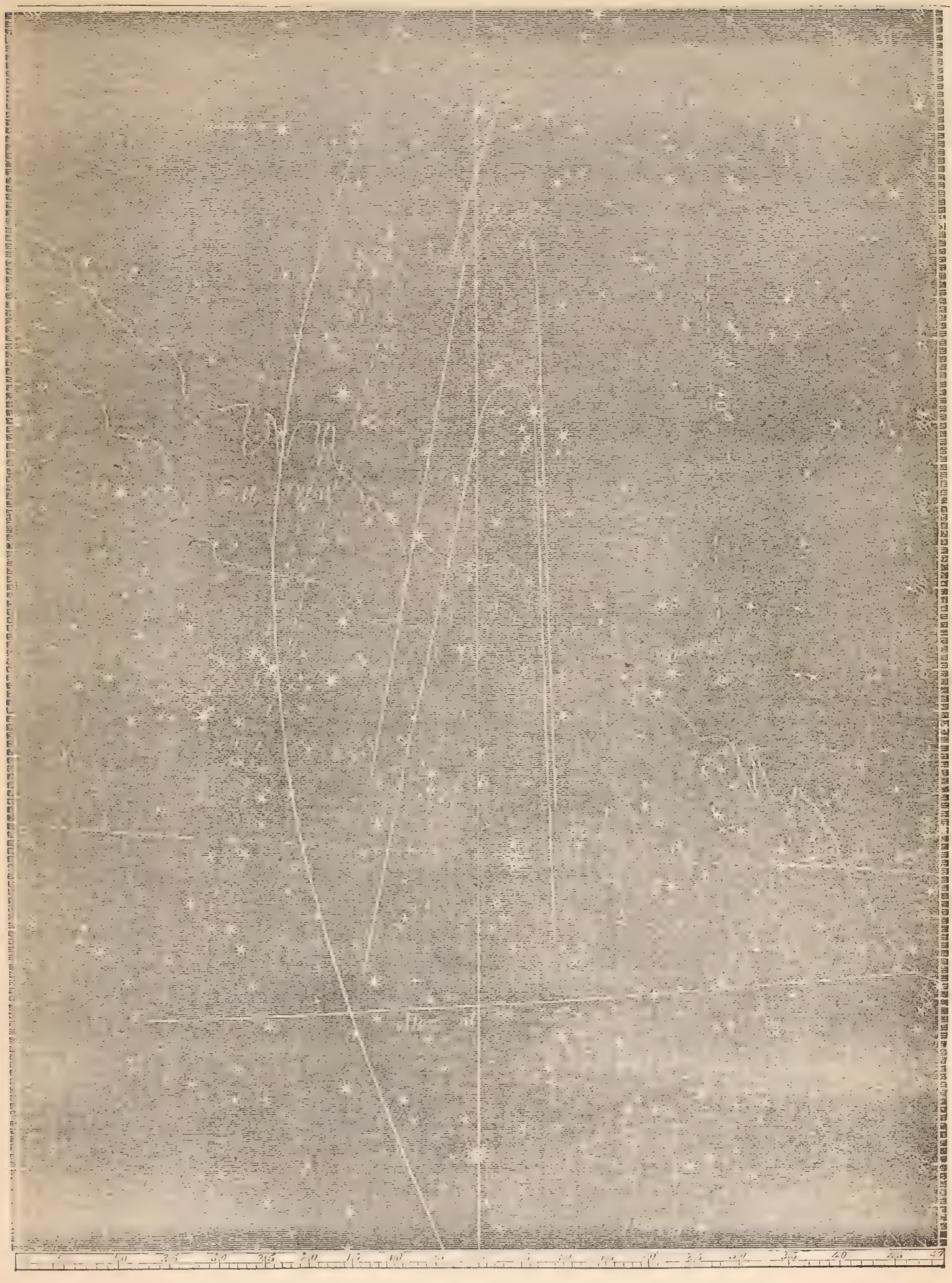
No. 317.

APRIL 11th, 1855: Evening.

Lat. at 8*h*, 15° 9′ N.: Lon. 48° 56′ W.
Sun set at 6*h*. 10*m*.
Stronger Light at 7*h*. 25*m*. and 8*h*. 45*m*.: Diffuse at 7*h*. 25*m*. and 8*h*. 40*m*.

Sky troubled with flying clouds, otherwise very good for observations. In consequence of the clouds, I could not get reliable boundaries till $7^h\ 25^m$, nor again till $8^h\ 45^m$. Could not make out reliably the upper extremity of the Diffuse Light. At 10^h the Light was still distinct, but dim.

Went on deck again at midnight. I thought there was a brightness at the west, at midnight, along the Zodiacal Light course, but nothing certain could be made out. Tried a long time, as the sky was extremely favorable for observations, and thought sometimes that I could get boundaries (nearly the same as at $8^h\ 40^m$, but running higher up); but finally came to the conclusion that both boundaries and the Light itself were all very uncertain.



No. 318.

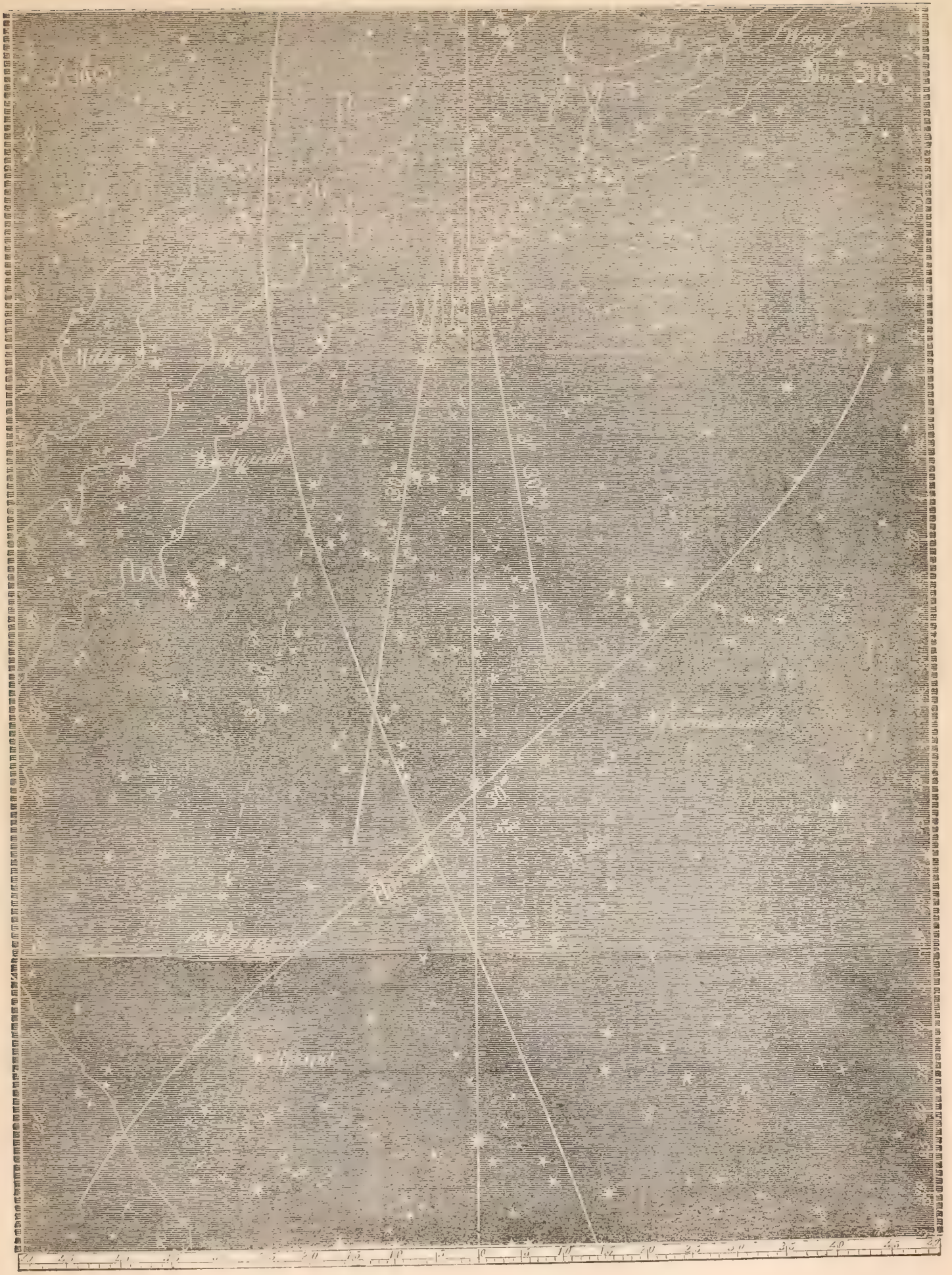
APRIL 13th, 1855: Morning.

Lat. at 3*h*. 30*m*., 18° 5′ N.; Lon. 51° 25′ W.
Sun rose at 5*h*. 4-½*m*.
Stronger and Diffuse Light at 3*h*. 30*m*.

Clouds last evening. Moon for some time in the morning, until this a. m. Went on deck soon after 3 o'clock; the Zodiacal Light, though quite distinct, too dim to give reliable outlines till 3ʰ 30ᵐ. At that hour, though the Light was not strong, the boundaries were well marked, except that of the Diffuse on the right hand (which I could not get at all); and those given in the chart may, I think, be fully relied on. The sky was extremely favorable for observations.

I still continue to notice, during the morning, the excess of meteors in the eastern sky over that of all other parts of the heavens. The officer of the deck reported a remarkably large one on the morning of the 11th, with a track which was visible, he thought, for several minutes.

Moon rose this a. m. at 3ʰ 46ᵐ.

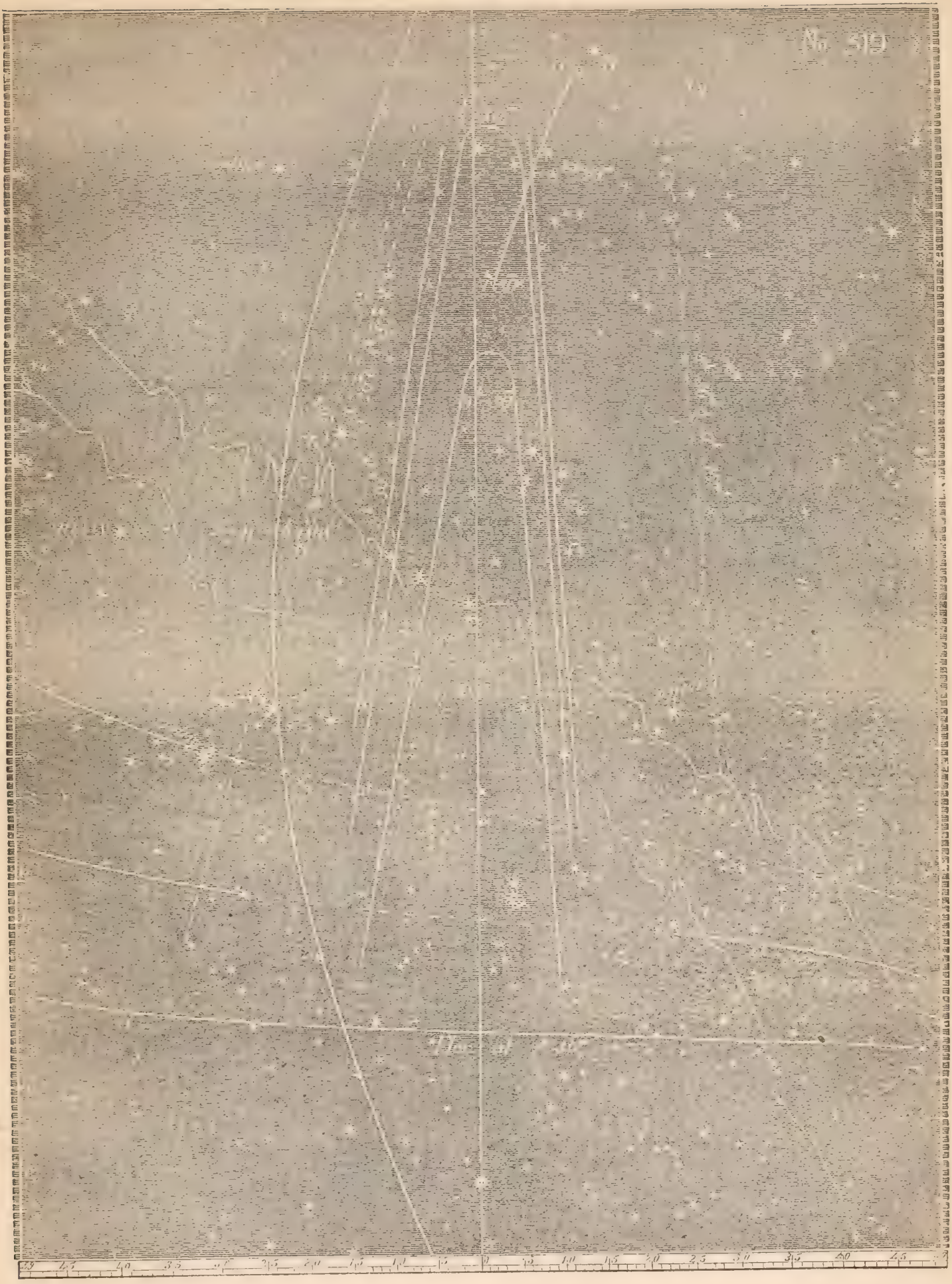


No. 319.

APRIL 13th, 1855: EVENING.

Lat. at 8*h*., 20° 9′ N.: Lon. 53° 19′ W.
Sun set at 6*h*. 13½*m*.
Stronger and Diffuse Light at 7*h*. 30*m*., 8*h*. 30*m*., and 9*h*. 30*m*.

In getting the lower part of the boundaries, this evening, I was somewhat troubled by clouds; but the sky above was clear and bright, and the lines given for that part of the Light are quite reliable. At $9^h\ 30^m$ the Zodiacal Light was still marked on the sky, but was quite dim. The sky at that time was very favorable.

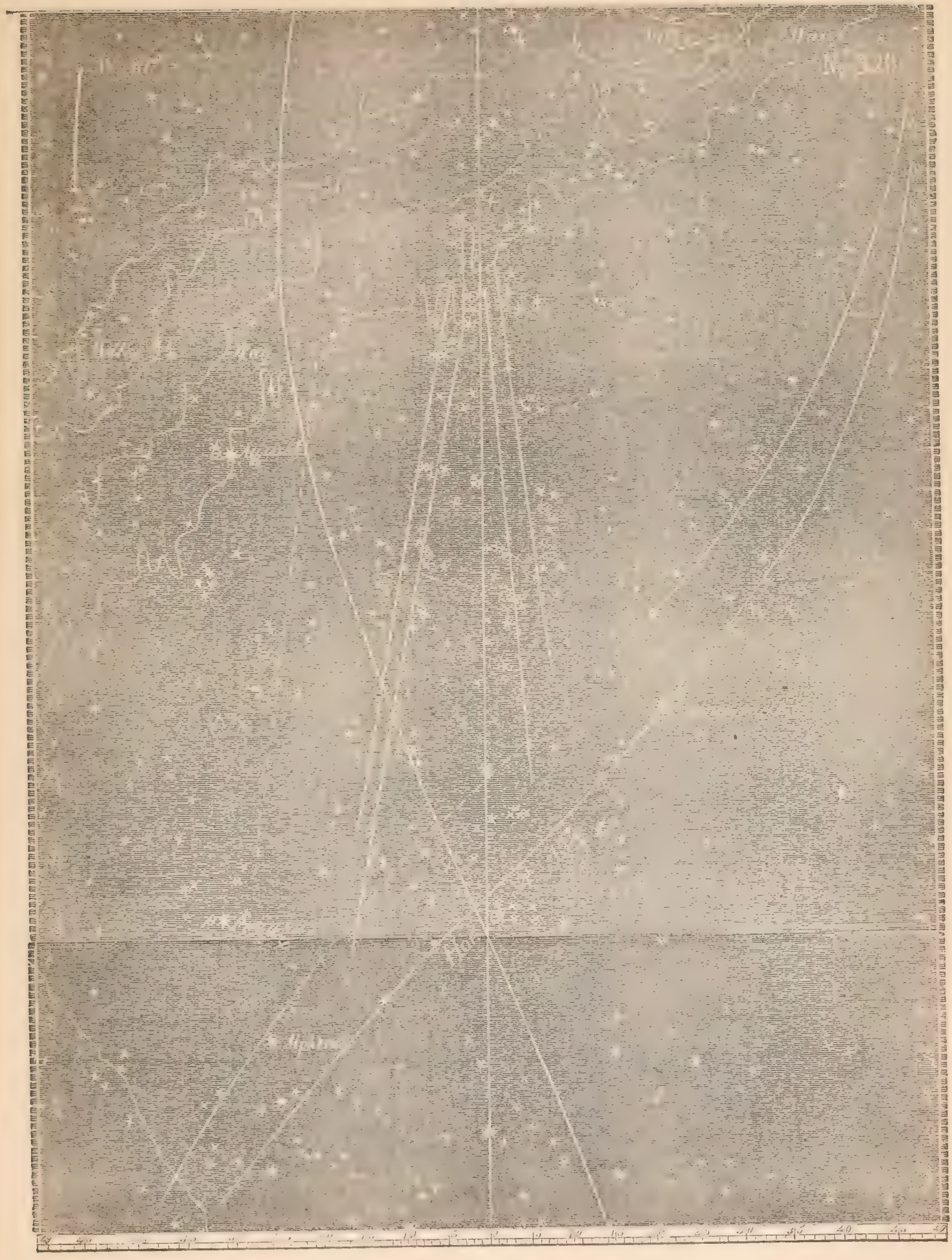


No. 320.

APRIL 14th, 1855: Morning.

Lat. at 4*h*., 20° 59′ N.: Lon. 54° 9′ W.
Sun rose at 5*h*. 46*m*.
Stronger Light at 3*h*. 30*m*. and 4*h*. 15*m*.: Diffuse at 3*h*. 20*m*.

The atmosphere not very favorable, and clouds on the right; still I was able to get reliable boundaries, except for the Diffuse on the right, where I could not make them out. The Stronger Light seemed to brighten up about $4^h\ 15^m$, as in pulsations; but of this I could not be certain. The moon, together with an early dawn, put an end to operations.



No. 321.

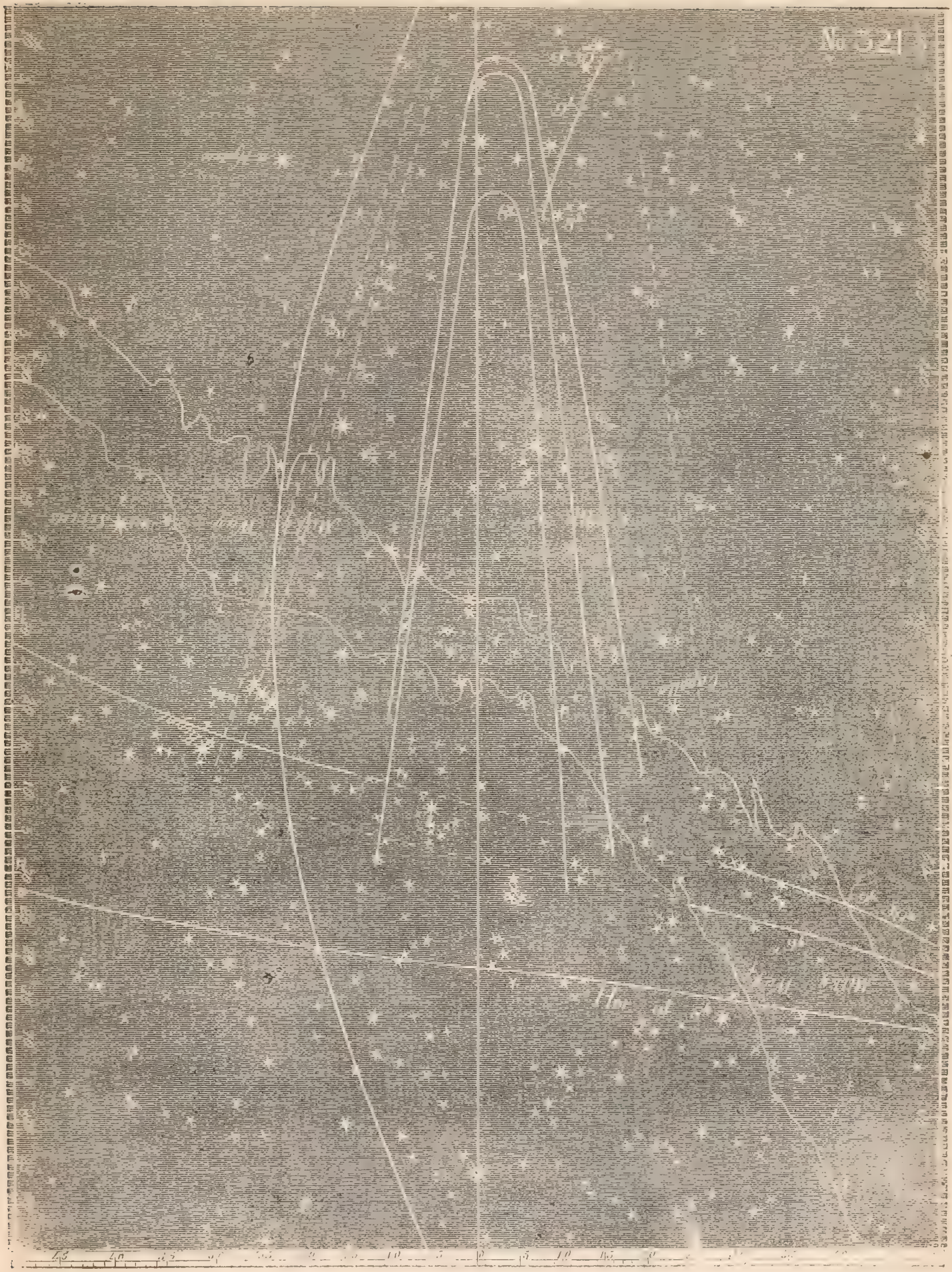
APRIL 14th, 1855: Evening.

Lat. at 8*h*., 22° 31′ N.: Lon. 55° 46′ W.

Sun set at 6*h*. 15*m*.

Stronger Light at { 9*h*. 0*m*. / 9 30 } Diffuse at 8 o'clock.

Cloudy till 8 o'clock. Sky, at that hour, also troubled by flying clouds; but the Zodiacal Light was very strong, and I was able to catch outlines between the clouds. The Zodiacal Light this evening was very brilliant. At $9^h\ 30^m$ the clouds had disappeared, and the sky was remarkably fine for observations. The Zodiacal Light was still quite strong.

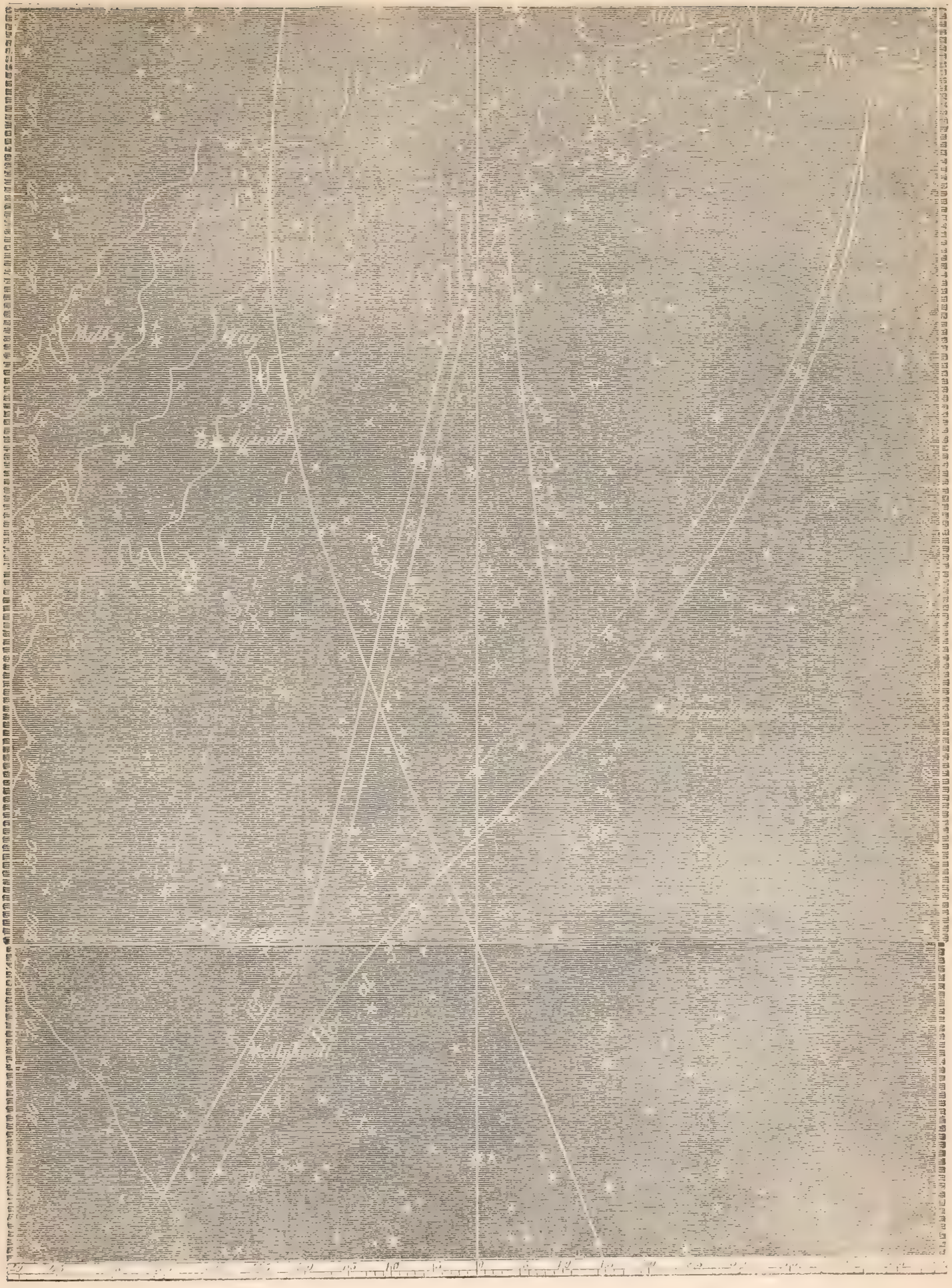


No. 322.

APRIL 16th, 1855: Morning.

Lat. at 3*h*. 30*m*., 25° 28′ N.: Lon. 59° 19′ W.
Sun rose at 5*h*. 40*m*.
Stronger Light at 3*h*. 15*m*. and 4*h*. 15*m*.: Diffuse at 3*h*. 15*m*.

(15th was Sunday.) Was on deck soon after 3 o'clock, and found the eastern portion of the sky very favorable for observations. The Zodiacal Light, however, was dim; and its boundaries were difficult to be made out. Soon after this, a strong light began to grow up towards the north, its strongest portion under β Pegasi. I concluded to wait for further developments before forming any opinion of its nature; but at $3^h\ 50^m$ clouds spread over the sky, and put an end to observations for the morning.



No. 323

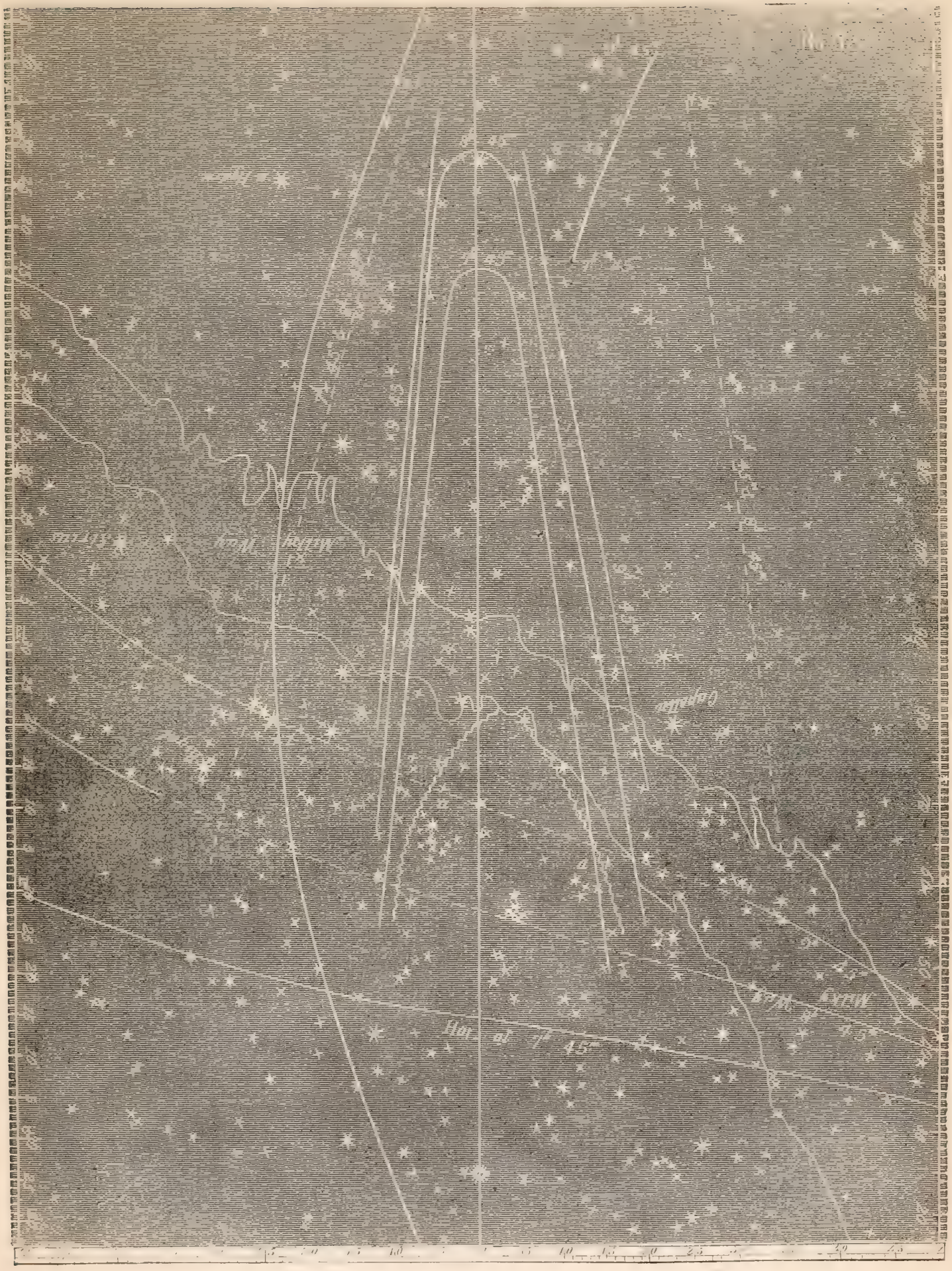
APRIL 16th, 1855: EVENING.

Lat. at 8*h*., 27° 04′ N.: Lon. 61° 35′ W.

Sun set at 6*h*. 21*m*.

Stronger Light at { 7*h*. 45*m*. / 8 45 / 9 45 } Diffuse at 7*h*. 45*m*. and 8*h*. 45*m*.

The night excellent for observations. The twilight is beginning to be long; got my first observation at $7^h\ 45^m$. At $7^h\ 55^m$, and thence onward, the Stronger Light was much the strongest (like the effulgence often noticed in the morning) within the zigzag *a a*; this was still so at $8^h\ 45^m$. At $9^h\ 45^m$ the Light had dimmed, but was still well marked in the sky, and gave reliable boundaries.

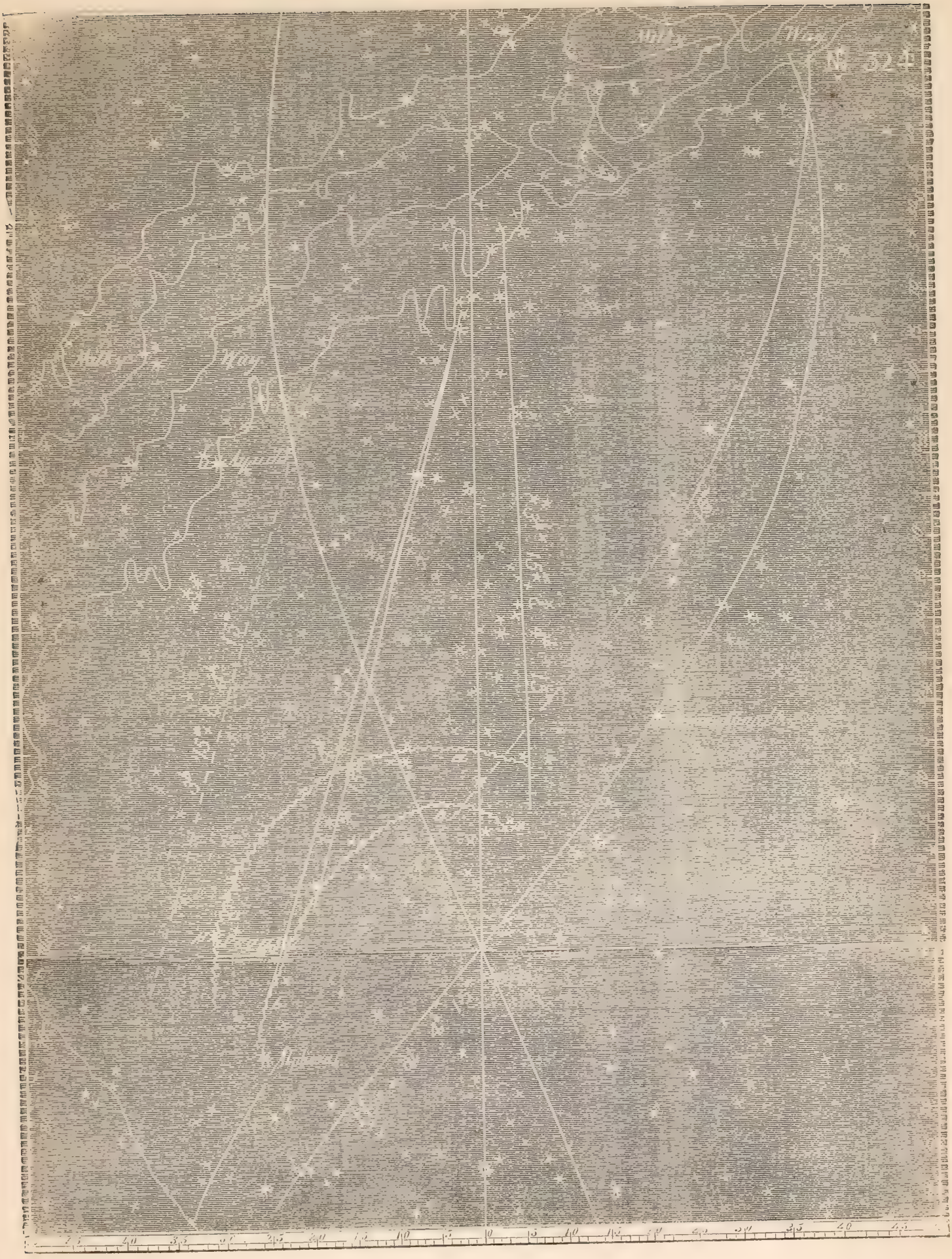


No. 324.

APRIL 17th, 1855: MORNING

Lat. at 4*h*., 27° 59′ N.: Lon. 62° 26′ W
Sun rose at 5*h*. 37*m*.
Stronger and Diffuse Light at 3*h*. 15*m*. and 4*h*. 15*m*
Zenith point at 3*h*. 15*m*., Lat. 51° 27′ N : Lon. 50° 50′.

The sky was very favorable, but the Zodiacal Light is now so dim as to make it very difficult to get reliable boundaries. Even at $4^h\ 15^m$, the boundaries of the upper part of even the Stronger Light could not easily be made out. I am, however, using the greatest care in getting outlines, both at evening and morning, on account of their importance for comparisons with those south of the equator. This morning, as yesterday, soon after $3^h\ 30^m$, a bright light began to grow up until it reached the boundary *a a* in the chart; afterwards, towards $4^h\ 37^m$, the Light within the zigzag *b b* became exceedingly brilliant, as if the sun were just going to rise there. About $4^h\ 41^m$ this appeared to dim considerably; at $4^h\ 43^m$ dawn had come.

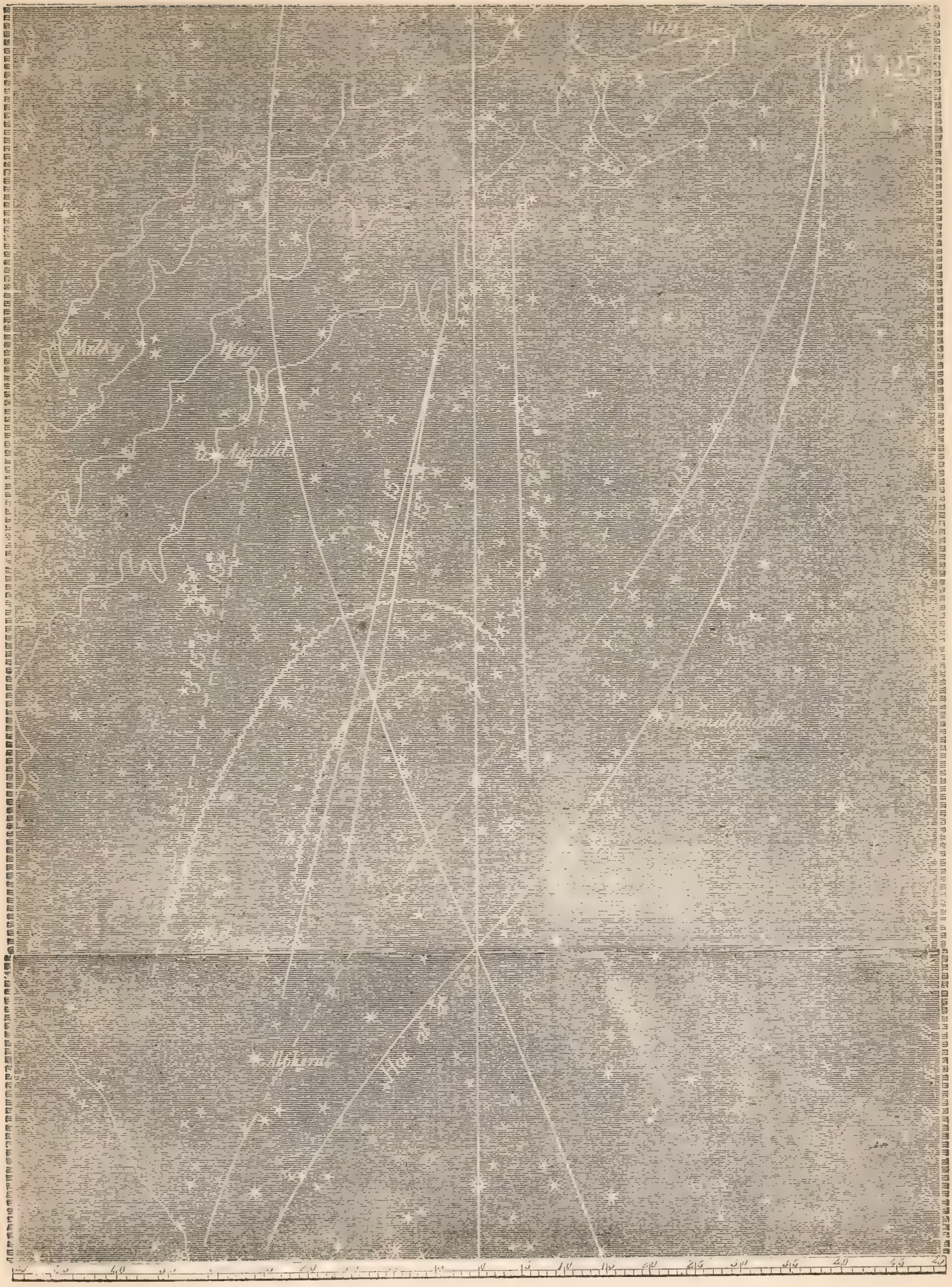


No. 325.

APRIL 18th, 1855: Morning.

Lat. at 4^h, 30° 30′ N.: Lon. 65° 39′ W.
Sun rose at 5^h. $34\frac{1}{2}^m$.
Stronger and Diffuse Light at 3^h. 15^m. and 4^h 15^m.
Zenith point at 3^h. 15^m., Lat. 53° 30′ N.: Lon. 251°.

Clouds last evening. This morning not very favorable for observations, and I cannot speak with entire confidence of the boundaries in the chart. I think, however, that they are correct. At 3^h 20^m there was a rapid, almost sudden, increase of light within the zigzag *a*: at 3^h 25^m, when I went on deck again, a more intense light appeared within the lower zigzag by *b b*. The southern boundary of the Diffuse Light could not be made out.



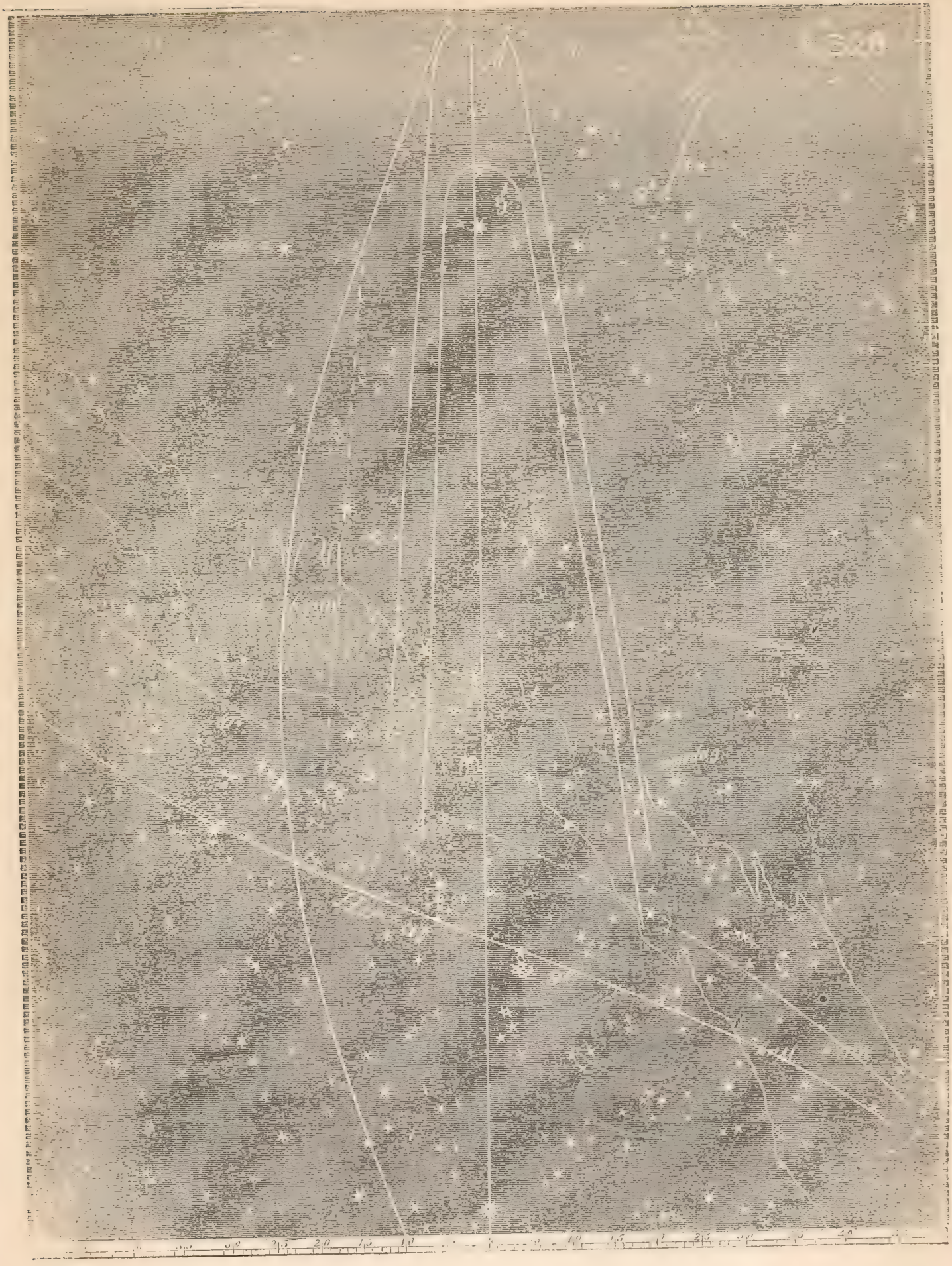
No. 326.

APRIL 18th, 1855: Evening.

Lat at 8*h*., 32° 10′ N.: Lon. 67°16′ W.
Sun set at 6*h*. 26½*m*.
Stronger and Diffuse Light at 9*h*. and 10*h*.

The sky, this evening, was perfect for observations; but the moon did not set till 9 o'clock. The Stronger Light was, at that hour, very brilliant below; and was quite bright as far up as Præsepe, above which, though dimmer, it could still be traced. At 10^h it was still very bright, the atmosphere being remarkably clear.

I have, in my recent markings on the chart, drawn the Stronger Light as extending far up in the sky; but it must be observed that its upper portion is very dim, sometimes scarcely to be made out. At 10^h could not bound the Diffuse Light reliably.

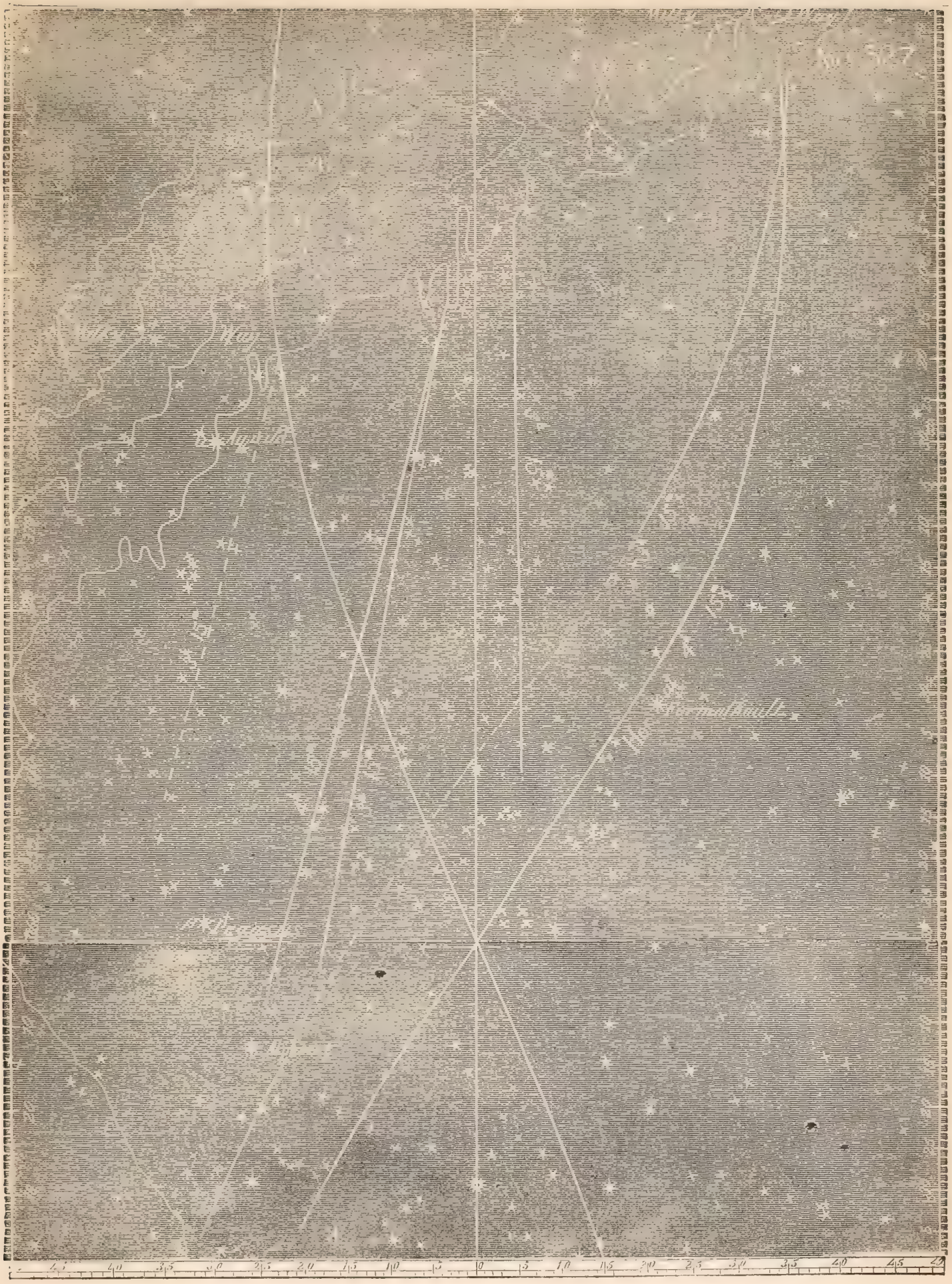


No. 327.

APRIL 19th, 1855: MORNING.

Lat. at 4*h*., 33° 12′ N.: Lon. 65° 16′ W.
Sun rose at 5*h*. 30*m*.
Stronger Light at 3*h*. 15*m*. and 4*h*. 15*m*.: Diffuse at 3*h*. 15*m*.
Zenith point at 3*h*. 15*m*., Lat. 55° 30 N.: Lon. 252°.

The sky, at $3^h\ 15^m$, very favorable, except some clouds on the left, near the horizon. I observed between the clouds that the effulgence which I have lately marked at *a a* was already there; but I could not get its boundaries. At $4^h\ 15^m$ the eastern sky was cloudy below, allowing me to see only the upper ends of the Stronger and Diffuse Light: on the right, no part of the Diffuse boundaries could be made out reliably.


Procyon
Regulus
Spica
Arcturus
Alphard
Alphecca
Antares
Vega
Altair
Fomalhaut
Deneb
Capella
Aldebaran
Rigel
Sirius
Betelgeux
Castor
Pollux
Procyon
Regulus
Spica
Arcturus
Alphard
Alphecca
Antares
Vega
Altair
Fomalhaut
Deneb
Capella
Aldebaran
Rigel
Sirius
Betelgeux
Castor
Pollux

No. 328.

APRIL 21st, 1855 : MORNING.

Lat. at 3*h*. 36*m*., 37° 38′ N. : Lon. 73° 9′ W.
Sun rose at 5*h*. 22*m*.
Stronger and Diffuse Light at 3*h*. 30*m*.

Clouds yesterday. The sky, this morning, was not favorable, the atmosphere being full of moisture; and I will not speak with confidence of the boundaries given. On the right, or southern side, I could not get any at all.

Blowing a gale.

No. 329.

MOON ZODIACAL LIGHT.

OCTOBER 21st, 1853.

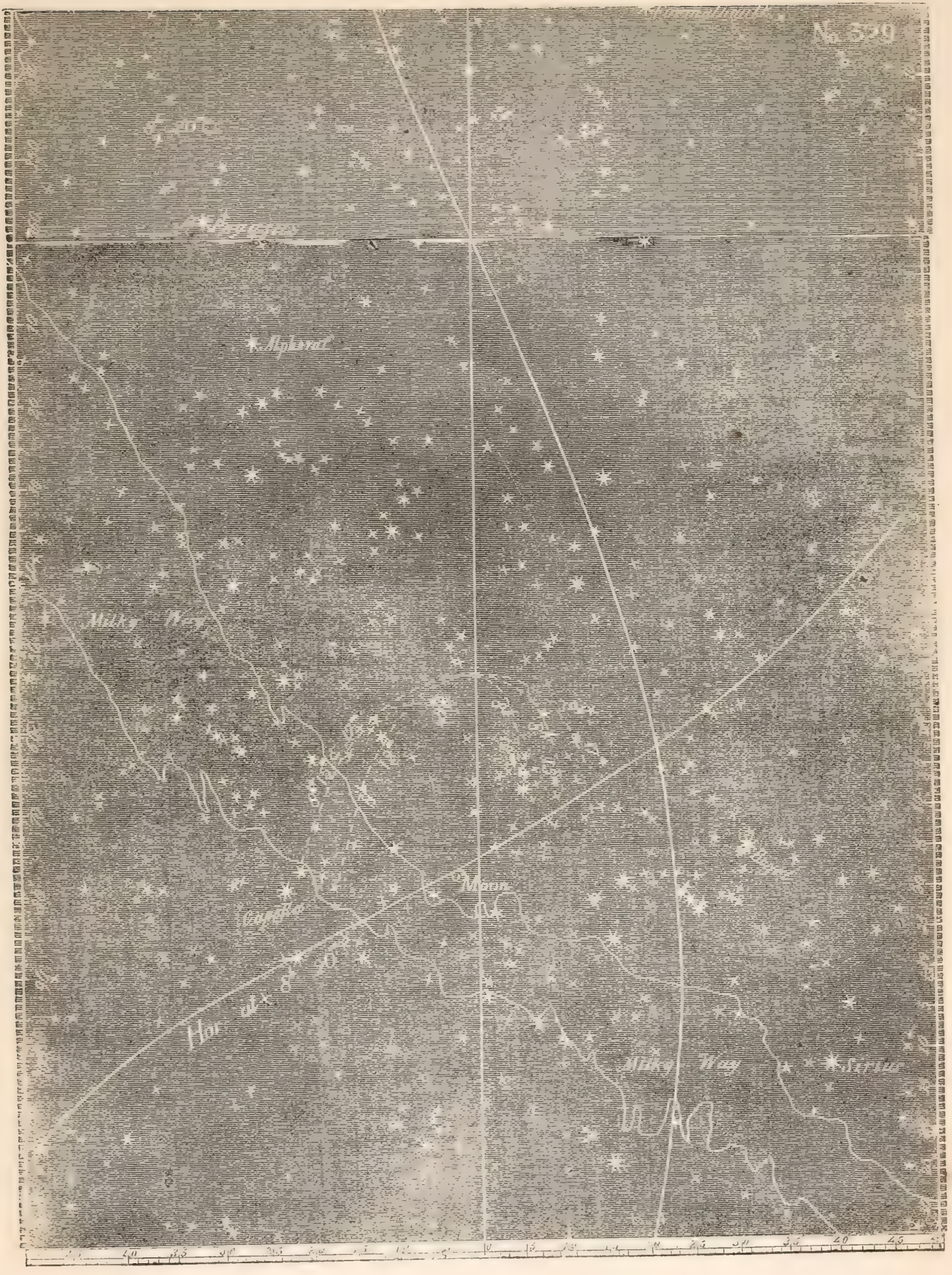
Lat. 22° 11′ N.: Lon. 113° 36′ E.
Sun set at $5^h.\ 28^m.$

Observations recorded at $\begin{cases} 8^h.\ 12^m. \\ 8\ \ 15 \\ 8\ \ 17 \end{cases}$

This evening, as the time approached for the moon's rising, I turned to see whether there might be a *lunar* Zodiacal Light. I have often made this attempt during the cruise (see especially March 29th, 1853*), but, until this evening, never could succeed to my satisfaction—probably in consequence of my looking too far up, and expecting this light too much to resemble the sun's Zodiacal Light. Last evening, at $7^h\ 30^m$, while finishing my observations in the west, the quartermaster on duty said to me, "The moon is going to rise." I went over soon after to look at the sky, and was struck at once with some resemblance to the sun's Zodiacal Light, but was too uncertain to do more than to watch it carefully. There was also scarcely time to get my star-charts and to make annotations. By-and-by, however, the sudden lateral spread of light (exactly like that in the morning, when the Zodiacal Light changes to that of dawn or atmospheric light) was so striking as greatly to remove my doubts. It was then, however, too late for taking outlines. So I was prepared this evening. At $7^h\ 56^m$, a faint and rather doubtful light began to appear from the Pleiades down, about the line of the ecliptic. At $8^h\ 2^m$, it was of a pretty decided character. I now sent for Lieut. M——, to request him to assist me with his judgment. At $8^h\ 10^m$, when he got on deck, there could be no doubt. He saw the light at once. It was exactly in the bounds of the sun's Zodiacal Light, with the shape this latter assumes. It extended rapidly, still, however, keeping within the Zodiacal Light bounds. Its boundaries, at $8^h\ 12^m$, $8^h\ 15^m$, and $8^h\ 17^m$, are given in the chart. It kept these last bounds till $8^h\ 22^m$, when it suddenly broke limits, and spread laterally so fast, that, in two minutes, no definite boundaries remained. The resemblance to the first breaking of morning dawn was very striking. Lieut. M—— agreed with me in all the above remarks, except the resemblance to the morning light breaking bounds suddenly, which last he has not observed.

* The record in my MS. for March 29th, 1853, was as follows:

"I have been trying to see whether there is any Zodiacal Light by the *moon*, which is now in a favorable condition for it, if there is any, and have, at times, thought that there is such light; but I cannot get hold of any thing reliable. There is no doubt, however, that, when the moon rises now, its light, cone-shaped or triangular, is first shown at the bottom of the Zodiacal Light place. It was so, very decidedly, on the 27th instant, when the moon was nearly at full, and the horizon was clear. This evening the horizon was obscured by cirri; but, at $9h.\ 50m.$, I had an observation of a light on the ecliptic, parabolic in shape, 52° in width, and ascending to 25° above the horizon. At $9h.\ 56m.$ it extended 62° on the horizon, and rose to a height of 32°. Then it ascended quickly to a height of 35° from the horizon, where it remained till the sky was all brightened rapidly by the approaching moon, which rose at ten minutes past 10 o'clock." (The Lat. then was about 2° N.: Lon. about 104° 21′ E.)


No. 599
Aquarius
Milky Way
Milky Way
Milky Way
Serpens

No. 330.

MOON ZODIACAL LIGHT.

OCTOBER 22d, 1853.

Lat. 22° 23′ N.: Lon. 113° 32′ E.
Sun set at 5*h*. 27*m*.
Observations at 9*h*. and 9*h*. 5*m*.
Zenith point at 9 o'clock, Lat. 26° 8′ N.: Lon. 356° 30′.

At 8^h 47^m the eastern sky began to show a speck of illumination. This gradually increased, keeping within the bounds of the sun's Zodiacal Light. Took its boundaries at 9^h and at 9^h 5^m, as in the chart, its northern end below Capella being hidden by clouds, which came gliding along, and prevented further reliable observations. At 9^h 6^m there was a very strong light, the star β Tauri being about its centre. At 9^h 10^m the Light suddenly broke bounds as before, and spread laterally and upward. Could not tell exactly when the moon rose, the island of Cumsingmoon being in the way.

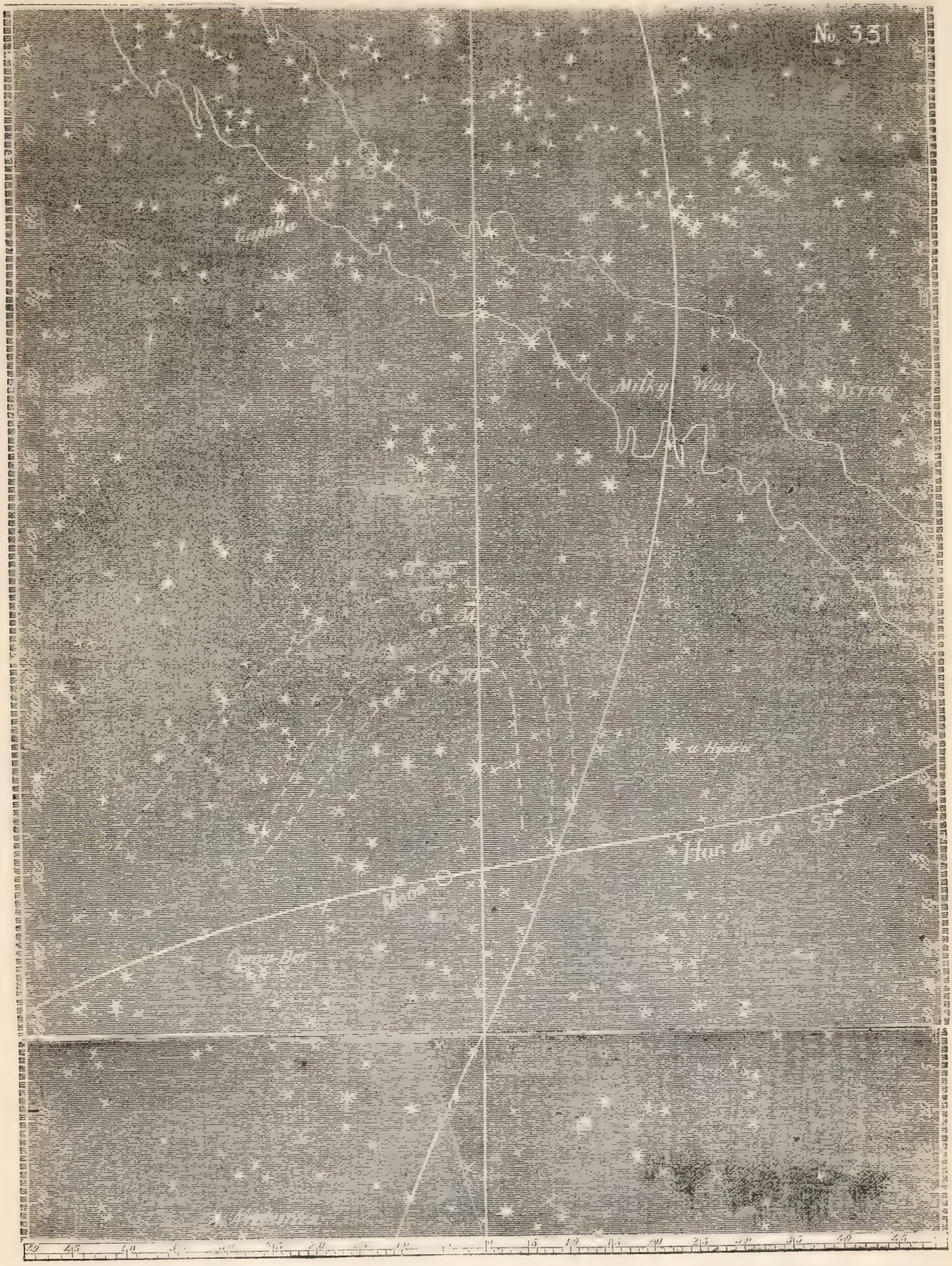
No. 331.

MOON ZODIACAL LIGHT.

FEBRUARY 14th, 1854.

Lat. 35° 19′ N.: Lon. 139° 43′ E.
Sun set at 5*h*. 36*m*.
Observations at 6*h*. 50*m*., 6*h*. 54*m*, and 6*h*. 56*m*.

Since my last notice of the moon Zodiacal Light, I have been watching anxiously for another opportunity for such observations; but the clouds have prevented until this evening, when I had an excellent one. There is no land obstruction, and this evening the sky was clear, except a dense haze, confined closely to the horizon. The moon rose before the night had entirely set in, but still the darkness was sufficient to afford a good exhibition of the Light, which was as follows: At $6^h 40^m$ there was a faint blush in the usual Zodiacal Light path, but not distinct enough to give outlines. At $6^h\ 50^m$ it was decided, and I got boundaries as in the chart: $6^h\ 52^m$ the light was very bright, limits as before: $6^h\ 54^m$ limits enlarged, light nearly as strong as the best Sun's Zodiacal Light: $6^h\ 55^m$ the disc of the moon showing itself, but with enlarged bounds of the Zodiacal Light, as in the chart. At $6^h\ 57^m$ the light had broken bounds, and was now atmospheric moonlight. The breaking bounds was very sudden and rapid.


No. 331
Milky Way
Procyon
Regulus
Spica
Virgo
Leo
Corvus
Crater
Hydra
Sextans
Antlia
Vela
Puppis
Pyxis
Monoceros
Canis Min.

No. 332.

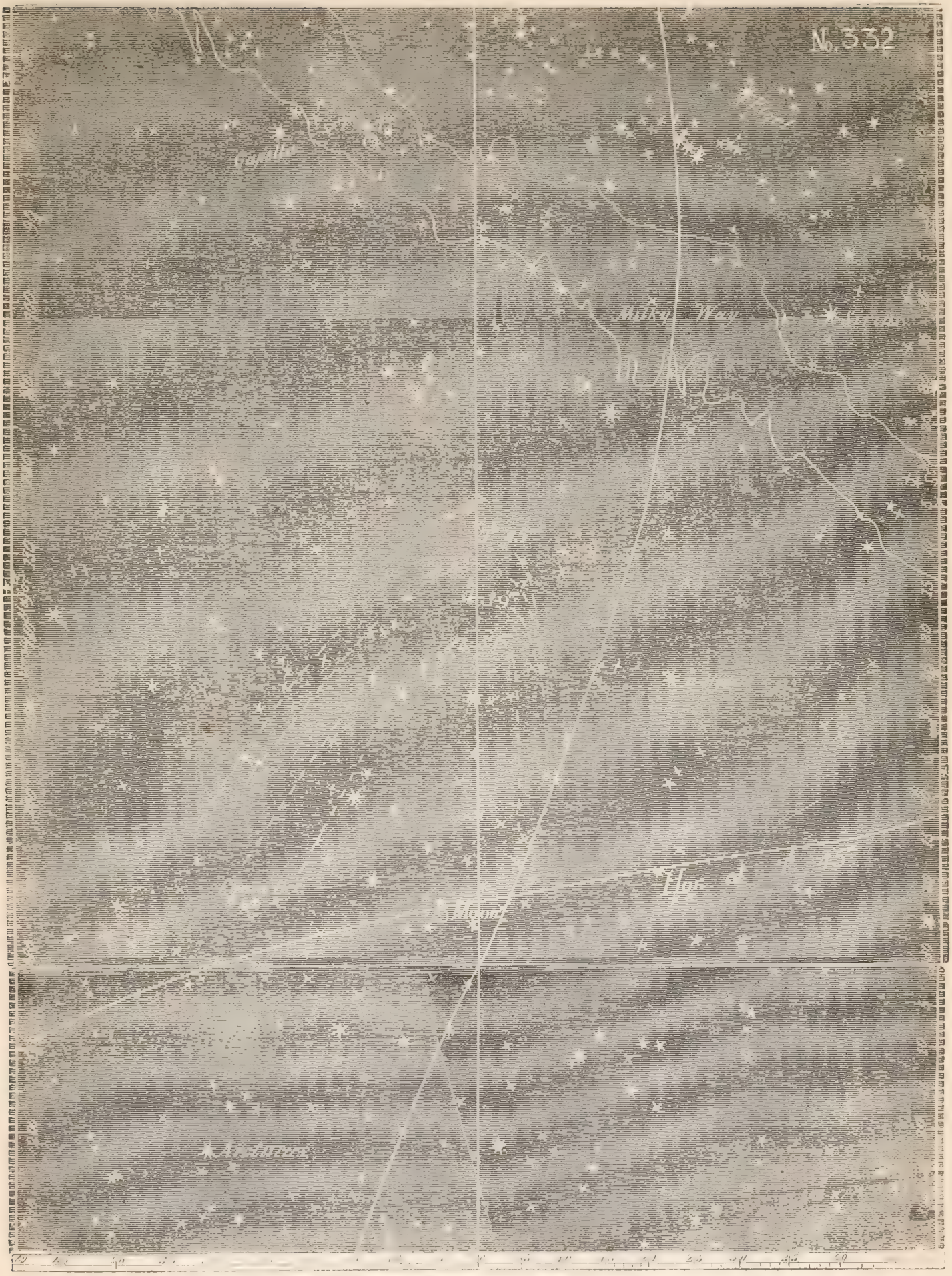
MOON ZODIACAL LIGHT.

FEBRUARY 15th, 1854.

Lat. 35° 19′ N.: Lon. 139° 43′ E.
Sun set at 5*h*. 36½*m*.
Observations at 7*h*. 35*m*., 7*h*. 37*m*., 7*h*. 39*m*., 7*h*. 43*m*., and 7*h*. 45*m*.

The eastern sky was excellent for observation, except a belt of whiteness generally along the horizon, and so wide as to make it difficult to get the boundary at the southern side of this Zodiacal Light, except at its upper part. The observation was very satisfactory. At $7^h\ 30^m$ I thought I could see a very faint tinge in the usual Zodiacal Light boundary, but was doubtful: $7^h\ 33^m$ a tinge, not doubtful, but too indefinite to give boundaries: $7^h\ 34^m$, decided: $7^h\ 35^m$, got boundaries (see chart): $7^h\ 37^m$, bounds as before, but Light stronger: $7^h\ 43^m$, very bright, especially about its lower end: $7^h\ 45^m$, as in chart, bright: $7^h\ 47^m$, general light beginning, and boundaries not so clear; but at this time, and till $7^h\ 53^m$, seem to be about as at $7^h\ 45^m$: $7^h\ 52^m$, disc of moon begins to show itself, but in the haze: $7^h\ 53^m$, general moonlight.

The difference between the elevation of the Light, this evening and the 14th, was doubtless caused by the long twilight here; in consequence of which, darkness on the 14th had not fully set in at the time of that observation, and thus the Zodiacal Light was not fully revealed that evening.


No. 332
Milky Way
Serpens
Hydra
Antlia

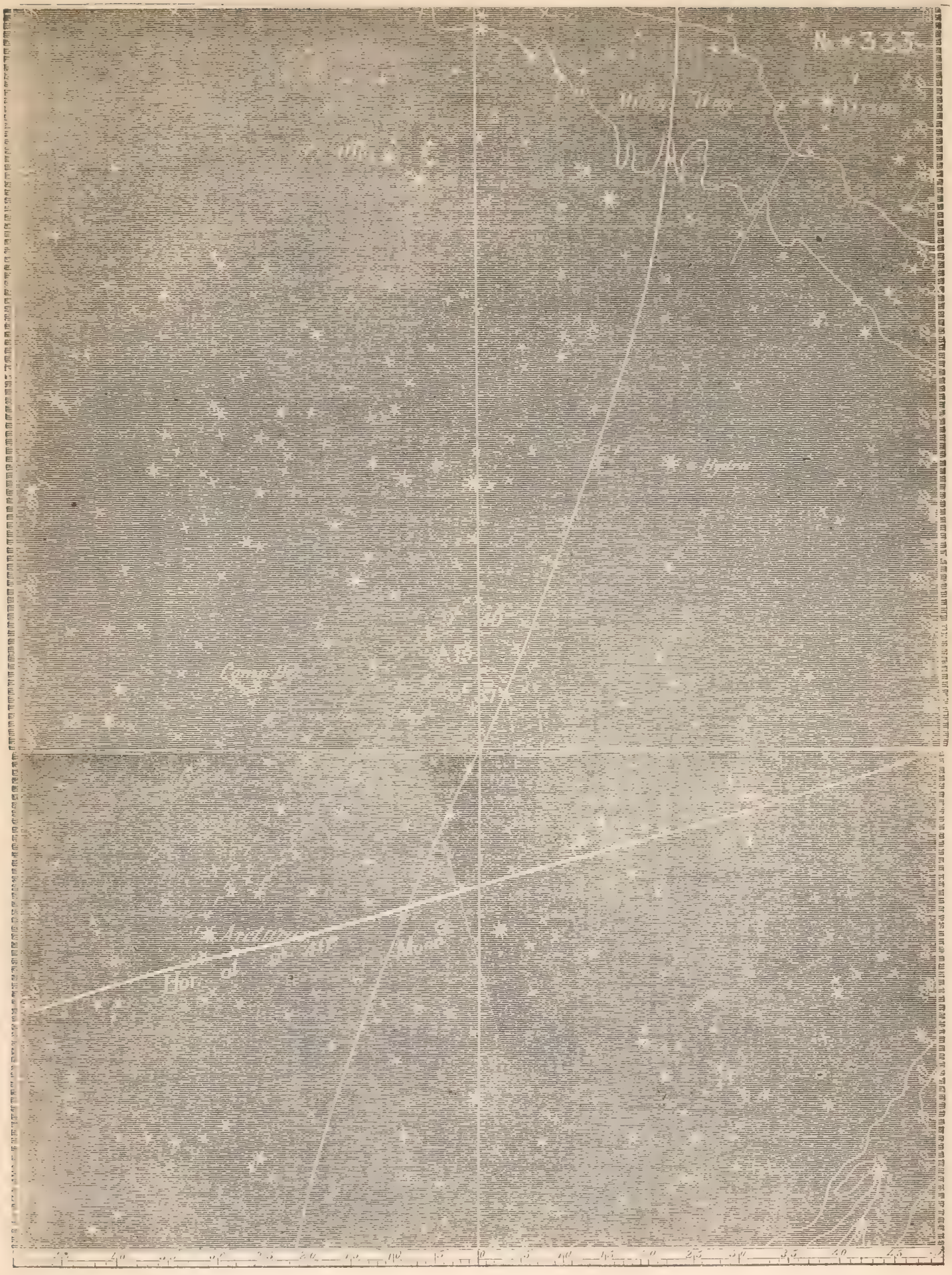
No. 333.

MOON ZODIACAL LIGHT.

FEBRUARY 17th, 1854.

Lat. 35° 19′ N.: Lon. 139° 43′ E.
Sun set at 5*h*. 40*m*.
Observations at { 9*h*. 33*m*. / 9 40 / 9 45

* * * * At the proper time I turned towards the east to make observations, fearful, however, that some clouds that came hurrying on would interfere. The evening, in other respects, was very favorable; the large stars showing themselves distinctly, immediately after being lifted above the horizon. At 9^h 37^m, the Light being then quite strong, I got the boundaries marked *a*; at 9^h 39^m *b*; the Light then being very bright. At 9^h 40^m the boundaries were at *c*, and the Light was then as bright as the sun's Zodiacal Light ever is. Clouds then slid over, and I could no longer get reliable outlines; but the Light, as seen between the clouds, still remained very strong. At 9^h 46^m the Light broke bounds and spread; and, at 9^h 52^m, the disc of the moon began to appear.


N. 323
Mizar
Alcor
Dubhe
Merak
Algol
Capella
Procyon
Sirius
Rigel
Betelgeux
Aldebaran
Pleiades
Hyades

No. 334.

MOON ZODIACAL LIGHT.

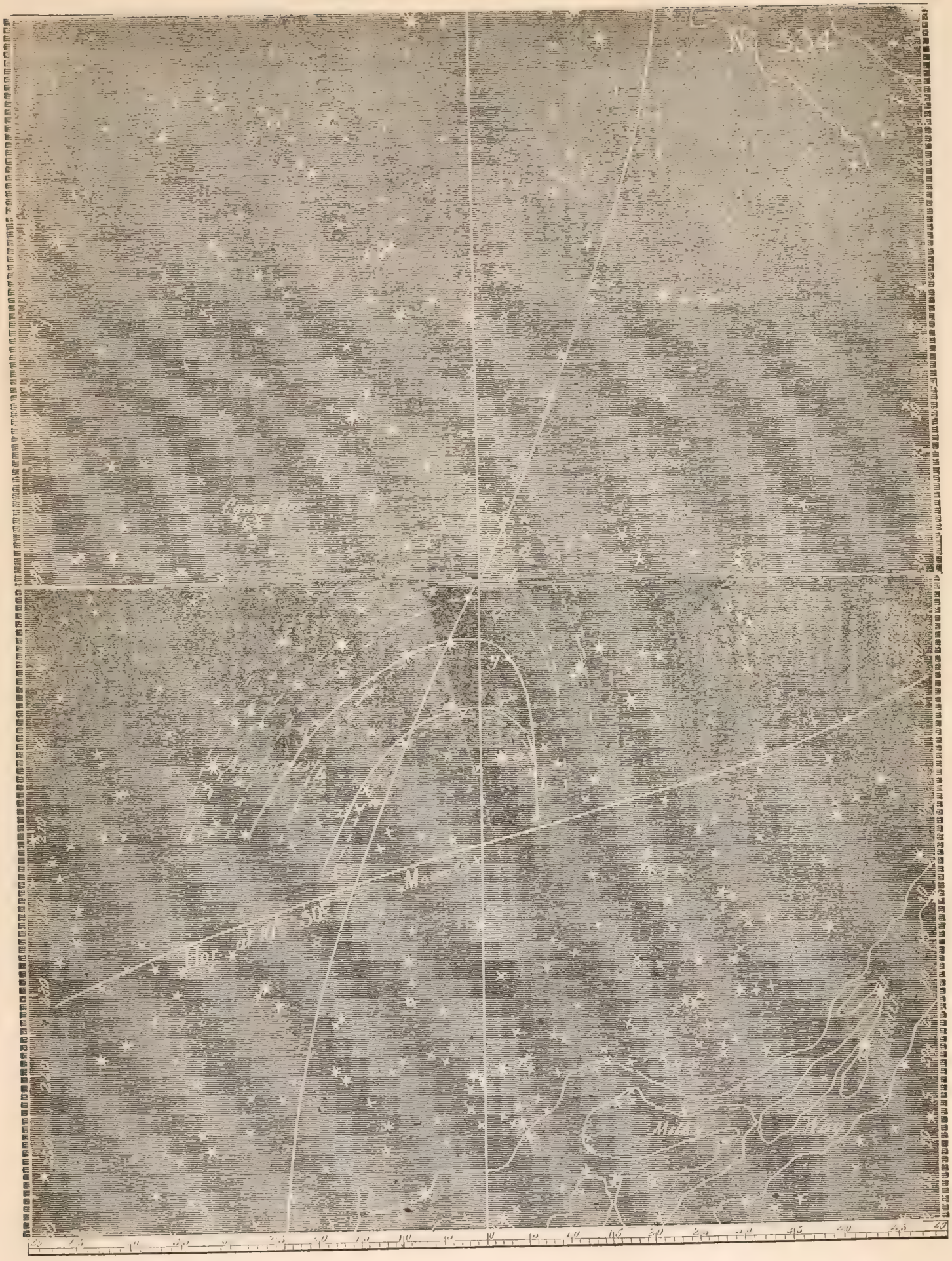
FEBRUARY 18th, 1854.

Lat. 35° 19′ N.: Lon. 139° 43′ E.

Sun set at 5*h*. 41*m*.

Stronger Light at 10*h*. 58*m*. and 11*h*. 2*m*.: Diffuse at { 10*h*. 44*m*. / 10 47 / 10 51 / 10 53 / 10 55 / 11 1

* * * * * * As the moon approached the eastern horizon, I turned to see what it would produce. At 10^h 39^m, the sky began to show a blush of light; 10^h 44^m, got boundaries as at *a*; 10^h 47^m, as at *b*, then very bright below Spica, not above: 10^h 50^m; very bright to 51 Virginis (*m* on chart): 10^h 51^m, boundaries to line *c*; 10^h 53^m, at *d*; 10^h 55^m, as at *e*; 10^h 58^m, a *stronger* light, boundaries marked by line *x* (it had shown itself before, but I did not take its boundaries); 11^h 1^m, as at *f*; 11^h 2^m, Stronger Light at *y y*; Diffuse as at last; 11^h 3½^m, the edge of the moon's disc shows itself. The eastern sky was remarkably fine for observations.


N 334
Capella
Aldebaran
Horizon
Milky Way

No. 335.

MOON ZODIACAL LIGHT.

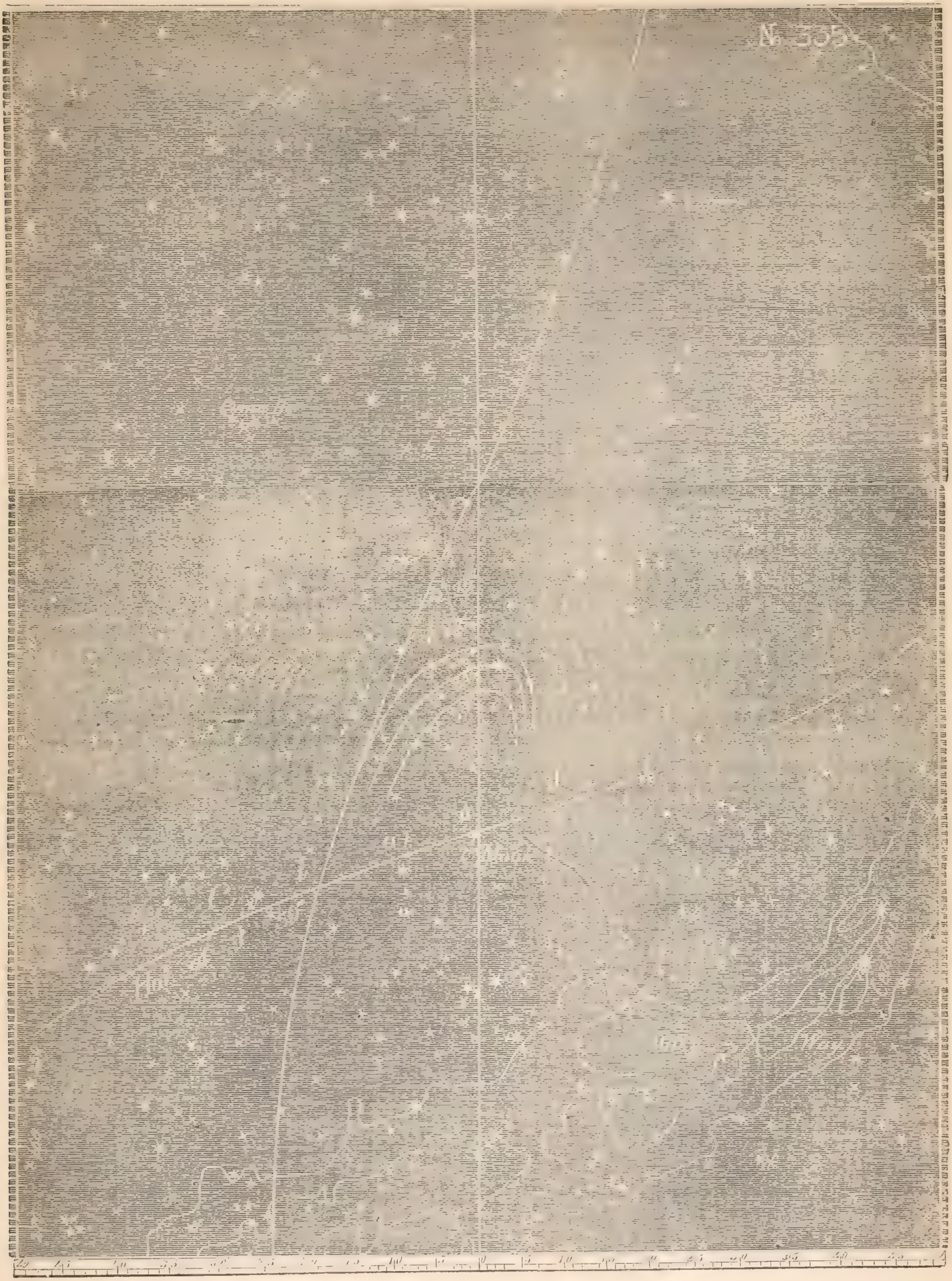
MARCH 18th, 1854.

Lat. 35° 26′ N.: Lon. 139° 42′ E.

Sun set 6*h.* 5*m.*

Stronger Light at { 9*h.* 50*m.* / 9 54 / 9 56 } Diffuse { 9*h.* 46*m.* / 9 49 / 9 51 / 9 55

The sky at the eastward was clear, except a narrow cloud near the horizon; and at $9^h\ 30^m$ I began to watch, to see what the moon, now approaching the horizon, would produce. There was at this time a singular paling of the sky—indeed, I think I may say a positive light—within the dotted marks on the chart. I called one of the quarter-masters, and asked him if he could discover a brightness along there, which he immediately did; although when I asked him to bound it, he placed it a little further to the north than I did. After a while the moon's Zodiacal Light clearly commenced, and at $9^h\ 46^m$, &c., I got the boundaries as in the chart. At $9^h\ 50^m$, a Stronger Light began to show itself decidedly, and I took its boundaries also at $9^h\ 54^m$ and $9^h\ 56^m$ (see $x\ y\ z$). At $9^h\ 57^m$, the disc of the moon began to show itself above the horizon. I notice that its light breaks bounds and spreads quicker on the right (or southwardly) than on the left. The streak of cloud did not interfere, materially, with the observations.


N. 305.

No. 336.

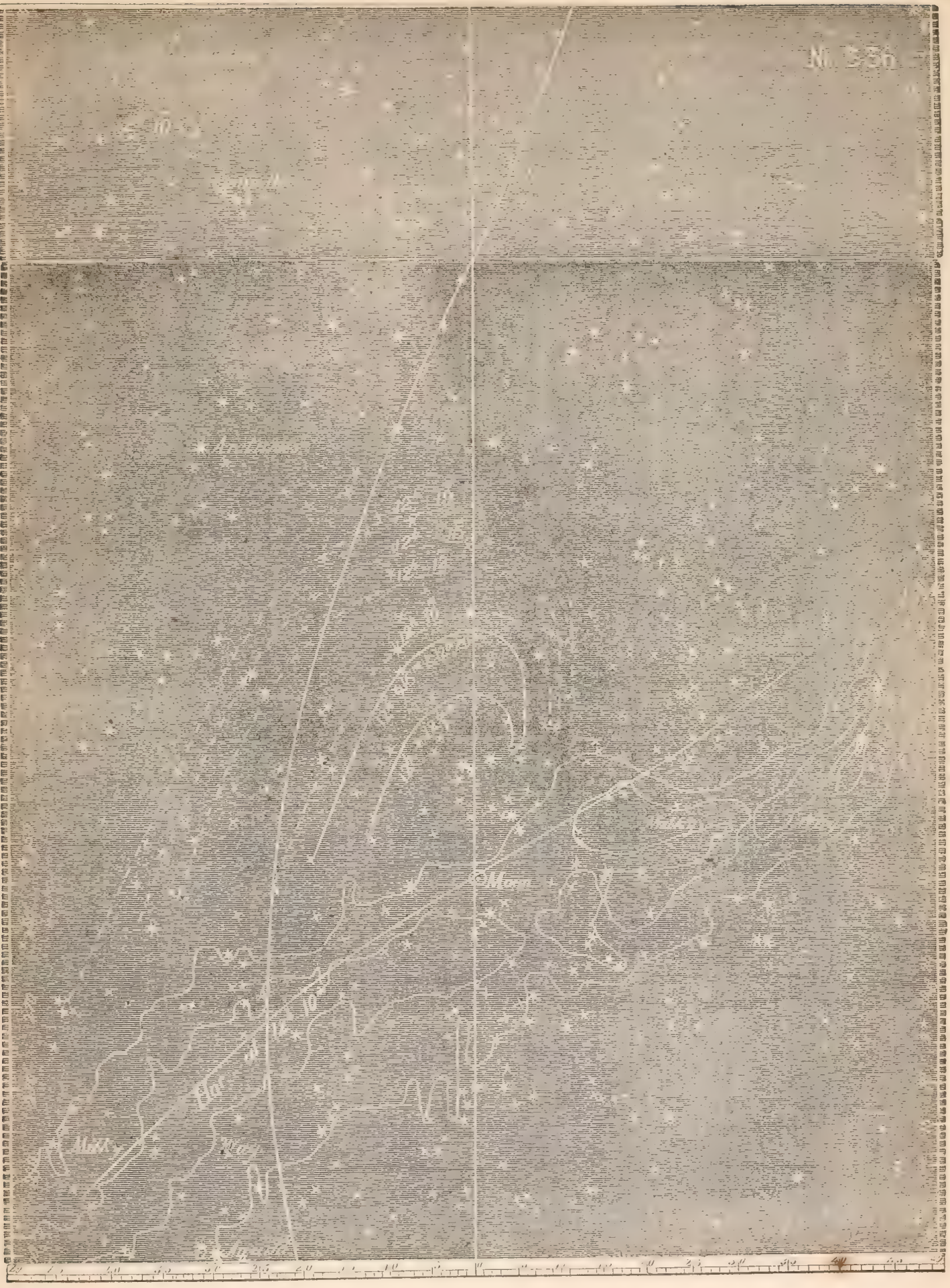
MOON ZODIACAL LIGHT.

MARCH 21st, 1854: Just after midnight.

Lat. 35° 26′ N.: Lon. 139° 42′ E.

Stronger Light at { 12½m. / 16 / 20 } Diffuse { 10m. / 12 / 15 / 19

Rose at midnight, to watch for the moon's Zodiacal Light. At $12^h\ 8^m$, the eastern sky began to exhibit a flush; at $12^h\ 10^m$, got boundaries; and thence on to $12^h\ 19^m$, as in the chart; at $12^h\ 12\frac{1}{2}^m$, $12^h\ 16^m$, and $12^h\ 20^m$, took boundaries of the Stronger Light; $12^h\ 20^m$, the moon's disc showed itself in some haze along the horizon. The sky was very favorable; and although the moon was now entering her last quarter, and her light was not at the strongest, still the Zodiacal Light was very distinct and strongly marked. The observation was extremely interesting, on account of the moon's distance from the equator, and also the great obliquity of the ecliptic to the horizon. Had this light been merely a reflection from the atmosphere, its highest point would have been in a very different direction (up towards Arcturus) from what it was.


N. 230
Mars
Mars

No. 337.

MOON ZODIACAL LIGHT.

APRIL 17th, 1854.

Lat. 35° 19′ N.: Lon. 139° 43′ E.

Stronger Light at 11*h.* 27*m.* and 11*h.* 34*m.*: Diffuse at 11*h.* 24*m.* and 11*h.* 34*m.*

* * * * Towards 11 o'clock, I turned towards the east, to watch for the moon's Zodiacal Light; a haziness along the horizon, and some distance up, together with approaching clouds, making the prospect there a very uncertain one. Still, I had reliable results, though got with some difficulty; and they are extremely interesting, on account of the great obliquity of the ecliptic to the horizon. Yet, great as this was, the Zodiacal Light stretched up along its old course, and the boundaries (except at the last, when I had to gather them from among the broken clouds) were very distinct. The last observations, at 11ʰ 28ᵐ, gave me no limits at the highest part, clouds at that place filling up the sky.

I thought this evening, as on one or two former occasions, that there was a paling of the sky far upward along the ecliptic line, long before the Light became decided at the lower end—say for half an hour previously; but I could not be certain about it. The moon showed itself at 11ʰ 22ᵐ; but it was so dimmed by the haze of the horizon, that the Zodiacal Light continued well defined for six minutes afterwards.

No. 338.

MOON ZODIACAL LIGHT.

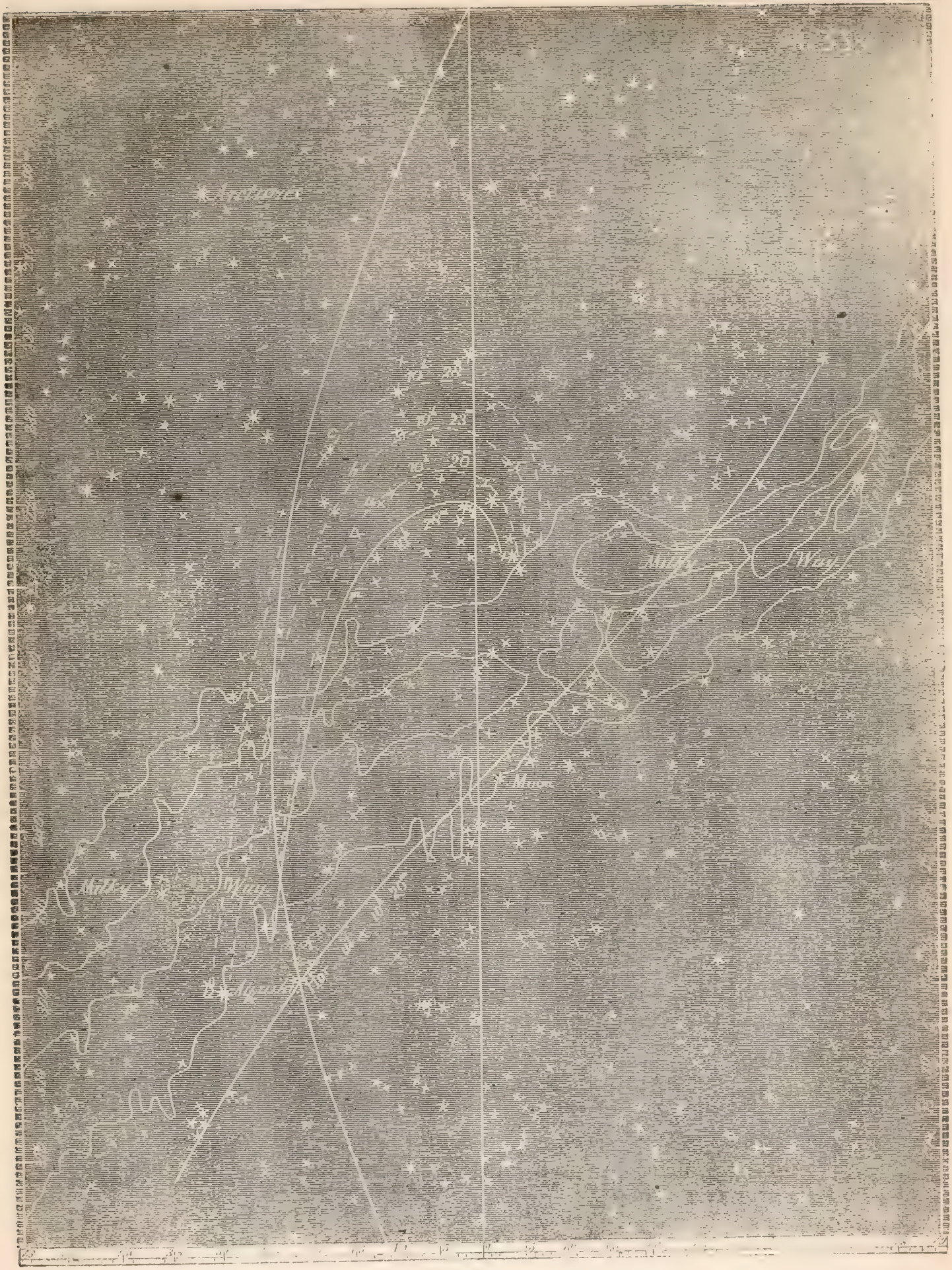
MAY 15th, 1854.

Lat. 40° 31′ N. : Lon. 142° 59′ E.
Zenith point, Lat 48° 37′ N. : Lon. 267°.

The eastern horizon had some haziness over it, yet not so great as to prevent the moon's disc from showing itself (though dimmed) as soon as it reached the horizon. Watched attentively for an hour previous to its rising, in order to catch every appearance of the sky. Thought sometimes that there was a paling of the sky up as high as Spica, from $9^h\ 37^m$ on; but this was very uncertain. On the whole, I rather conclude that there was none. Except the haziness, the evening was a very interesting one; for the angle of the ecliptic with the horizon is so small, that the moon approached very slowly, and so gave me ample time for observations, after its light first began decidedly to show itself. The moon was also now about its furthest possible distance from the equator; and this, together with the small angle of the ecliptic to the horizon, gave excellent opportunities for testing whether the Light is a reflection from the atmosphere piled into an equatorial ridge, or from something else. The conclusion soon became clear to my mind, that the former could not be the case. (See also the chart.)

At $10^h\ 8^m$ the sky began to show a faint blush, decidedly light from the moon. Could not get boundaries till $10^h\ 20^m$, when they were as in the line *a*; at $10^h\ 23^m$, they were as at *b*; $10^h\ 27^m$, still at *b*, but light strengthened; $10^h\ 28^m$, as at *c*; and now there might, perhaps, be called a Stronger Light, with the boundaries at *m*; but the haziness prevented this from equaling former exhibitions of that kind. At $10^h\ 29^m$, the upper edge of the moon showed itself above the smooth-sea horizon; but the haze there kept it so dim, that the boundaries *c* and *m* still continued till $10^h\ 31^m$.

The quick rounding off of the Light on the right side, as at *x x x*, was quite striking this evening. Had it not been Zodiacal Light, it would have naturally extended slantingly off on the right as well as on the left.


Arcturus
Milky Way
Milky Way

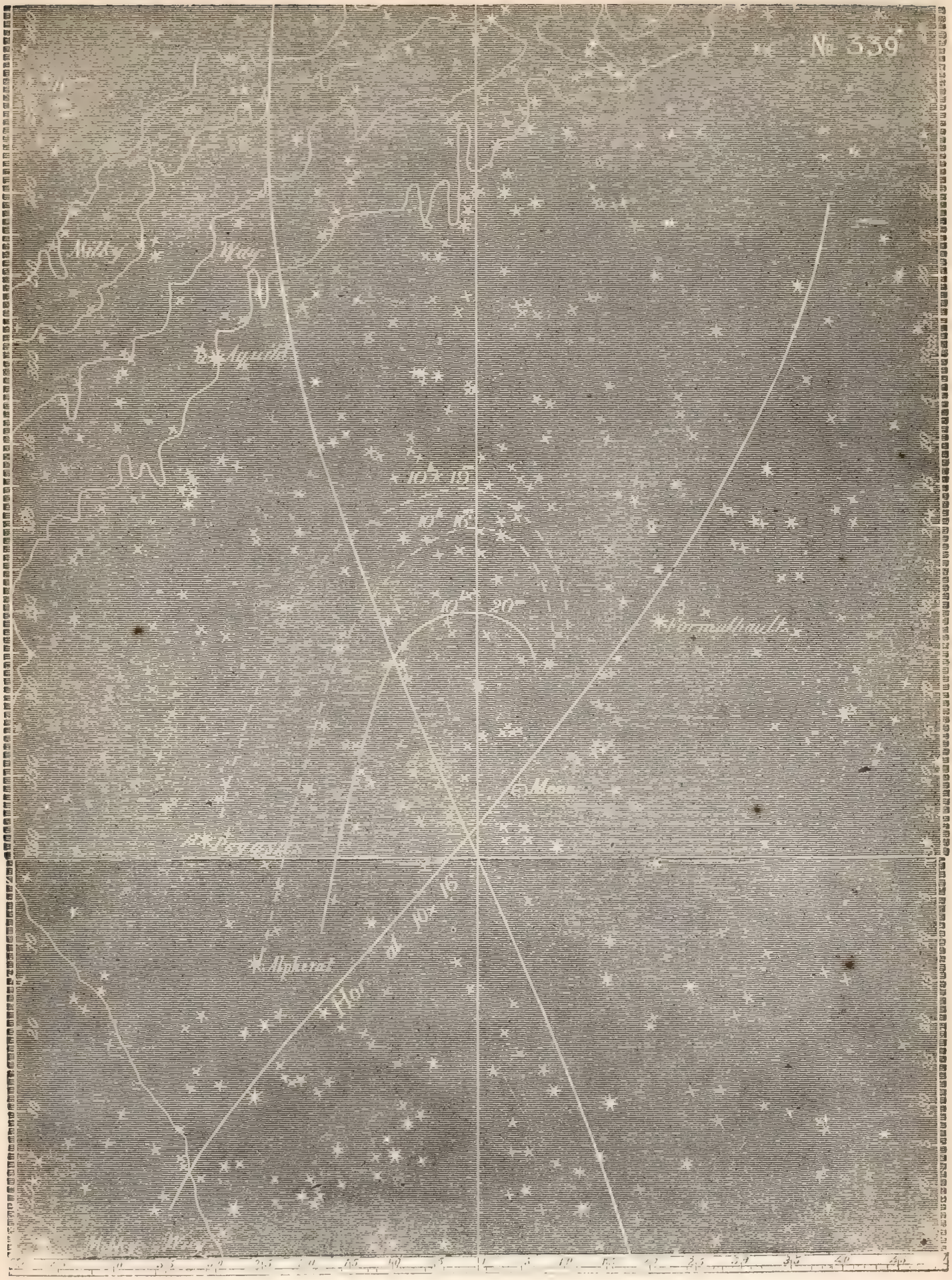
No. 339.

MOON ZODIACAL LIGHT.

JULY 14th, 1854.

Lat. 25° 9′ N.: Lon. 121° 46′ E.
Sun set at 6*h*. 48½*m*.
Stronger Light at 10*h*. 20*m*.: Diffuse at 10*h*. 16*m*. and 10*h*. 19*m*.

I watched, last evening, for a moon Zodiacal Light, but streaks of clouds in the east prevented any reliable results. This evening the sky was very favorable, and the Zodiacal Light was strongly marked; and was the more striking, because the ecliptic made a very low angle with the horizon. Took boundaries as at $10^h\ 16^m$ and $10^h\ 19^m$: and at $10^h\ 20^m$ the Light was so strong below, that I also took boundaries for a Stronger Light, as in the full line in the chart. Soon after this, the light spread suddenly on the right hand, so as to stretch out like that on the left—caused, probably, by the moon's rays having now reached our atmosphere. This rapid stretching out on the right was very striking.


№ 339
Milky Way
Aquila
Pegasus
Andromeda
Perseus
Alpheratz
Hor.

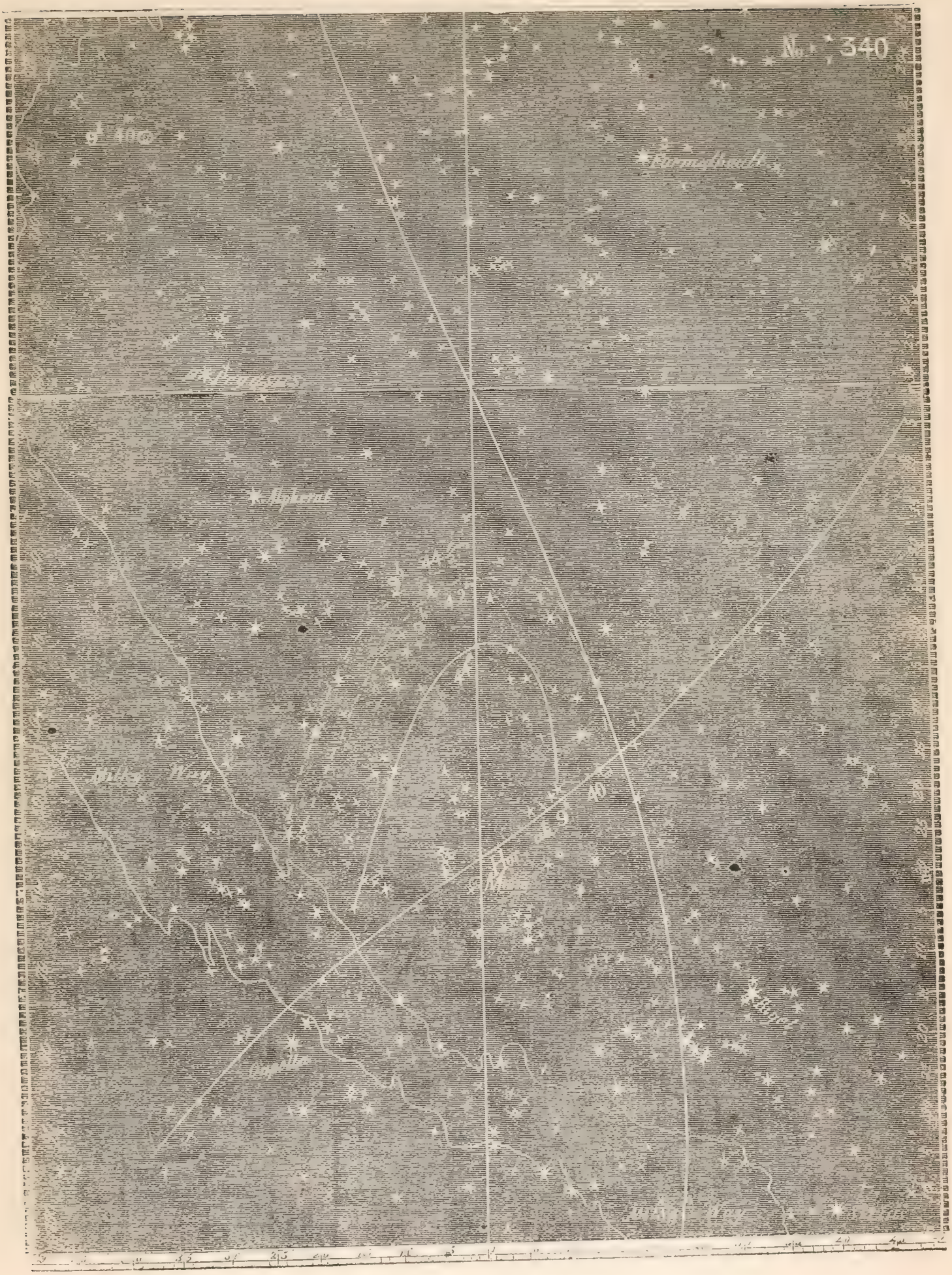
No. 340.

MOON ZODIACAL LIGHT.

SEPTEMBER 12th, 1854.

Lat. 22° 14′ N.: Lon. 115° 18′ E.
Sun set at $6h.\ 2\frac{1}{2}m.$
Stronger Light at $9h.\ 44m.$: Diffuse at $9h.\ 42m.$ and $9h.\ 44m.$

* * * * * * As the sky was so favorable for observations, I intended to watch for a moon Zodiacal Light, though the moon was not at its best time, being several nights after the full; but I was not on deck soon enough for its first show of light. However, I succeeded very well, as may be seen from the chart. The full line gives the boundary of a Stronger Light, which began to show itself about $9^h\ 44^m$. At $9^h\ 45\frac{1}{2}^m$ the Light broke bounds on the right, and, soon after, on the left; but there seemed to be, from this time on, for a while, a streak of paled sky along the ecliptic, running far up into the sky. I was not sufficiently certain about it, to warrant my putting it down on the chart; and it was over too soon for my getting other judgment than my own to bear on it. At $9^h\ 50^m$ the edge of the moon appeared above the line of the smooth horizon.


N. 340
Andromeda
Perseus
Algol
Milky Way
Cassiopeia

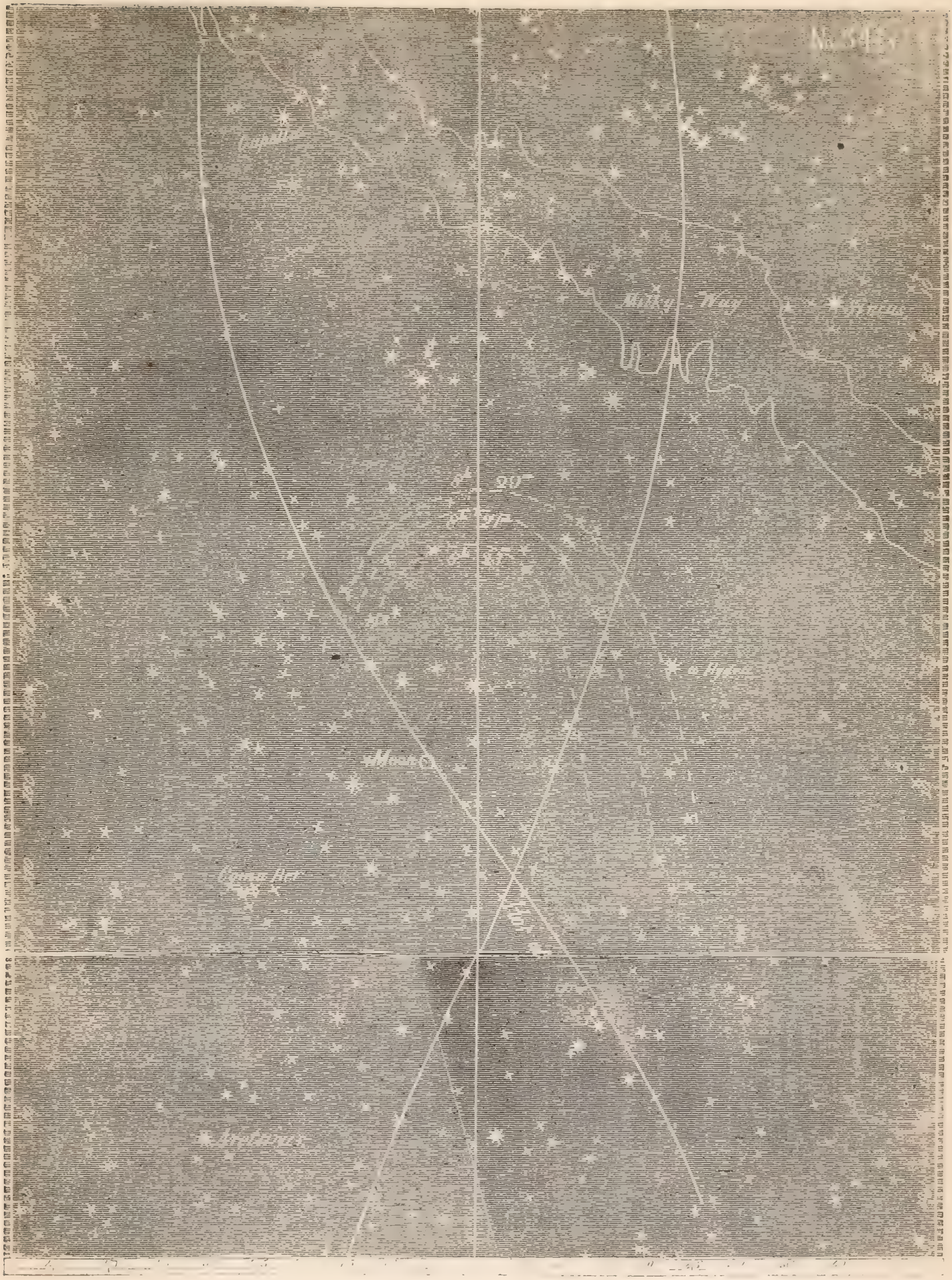
No. 341.

MOON ZODIACAL LIGHT.

FEBRUARY 3d, 1855.

Sun set $6^h.57^m$.
Lat. 33° 1′ S.: Lon. 71° 41′ W.
Observations at $8^h.23^m.$, $8^h.27^m.$, and $8^h.29^m.$

This evening, the sky being quite free from clouds and tolerably bright, I succeeded in getting a moon Zodiacal Light, as in the chart. The proximity of the ecliptic to the horizon, however, makes the evening Zodiacal Light now less striking than it was in lower latitudes. The upper edge of the moon's disc showed itself at $8^h\ 25^m$; but, there being a haziness along the horizon, the Zodiacal Light gave boundaries for two minutes afterwards.


Milky Way
Milky Way
90°
Comæ Ber.
Leo Minor

No. 342.

CASSINI'S OBSERVATION.

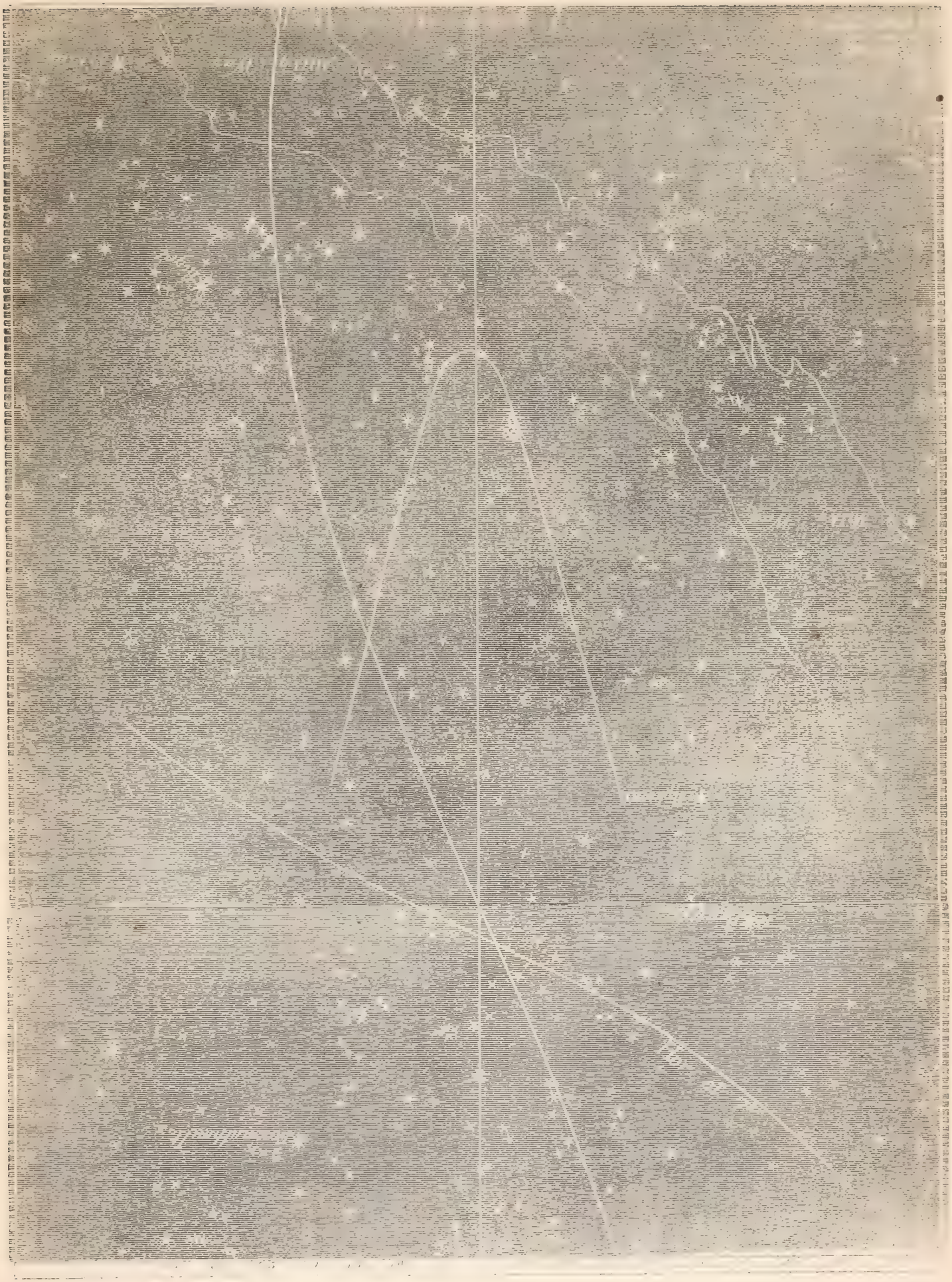
FEBRUARY 27th, 1685: Evening.

Lat. 48° 51′ N.: Lon. 2° 22′ W.

(Compare mine of February 24th, and 25th, 1854, Nos. 123 and 124; but in this, and all the subsequent comparisons, we must bear in mind that Cassini's latitude was north of my own; often considerably so.)

"Le 27 Février [1685] le terme septentrional de la lumière passait par l'espace qui est entre la tête d'Andromède et l'extrémité de l'aile de Pégase, par la première d'Aries, et au-delà des Pleiades, jusqu'au col du Taureau.

"Du côté du midi, el touchait le plus septentrionale des trois claires de la gueule de la Baleine, et celles qui sont dans la caisse du Taureau." [P. 160.]



No. 343.

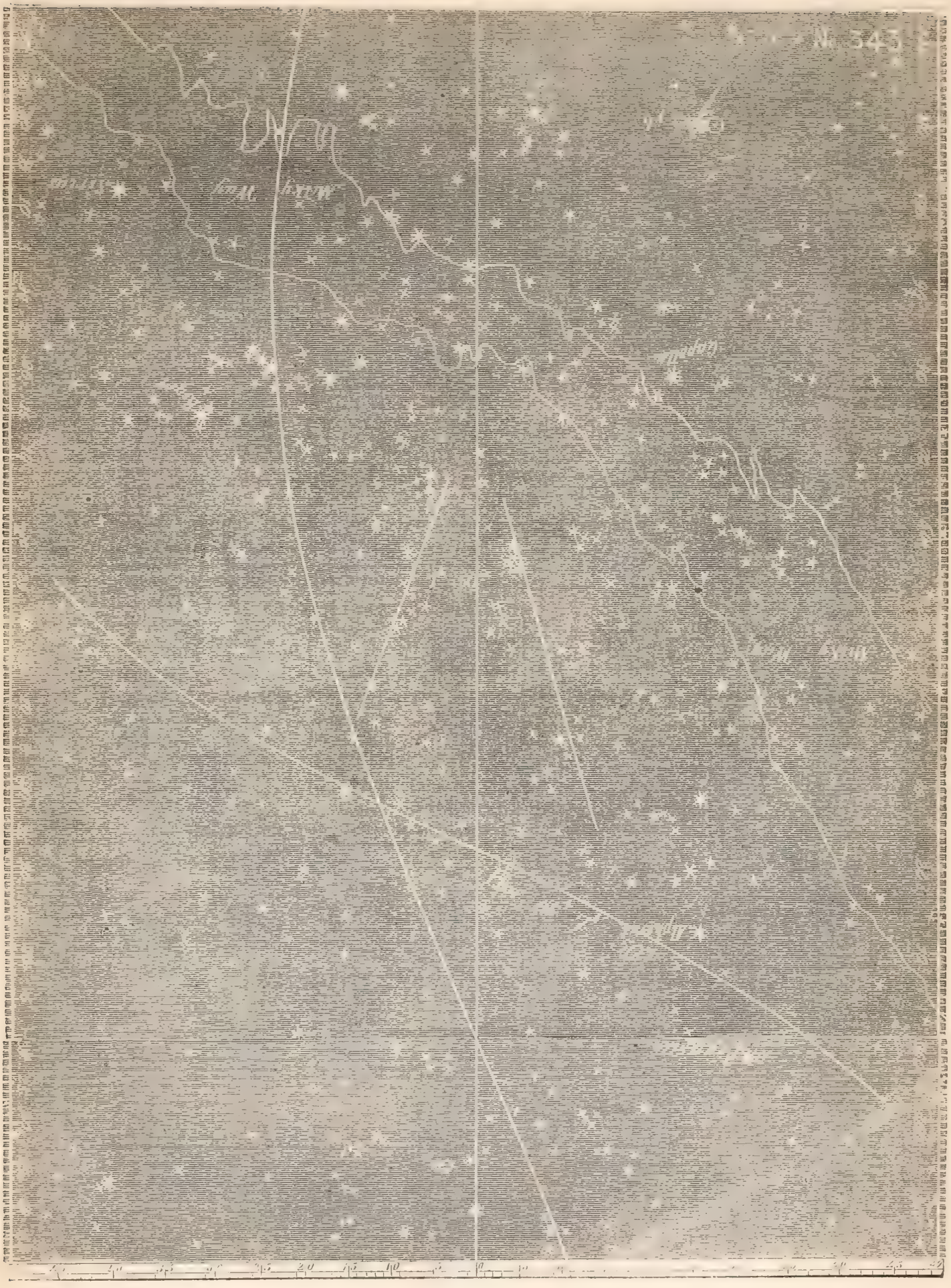
CASSINI'S OBSERVATION.

MARCH 22d, 1685: Evening.

Lat. 48° 51′ N.: Lon. 2° 22′ W.
Observation at 7*h*. 50*m*.

(Compare mine of March 20th, 1854, No. 128.)

"Le 22 de Mars [1685] à 7 heures 50 minutes, la lumière s'étendait jusqu'à la tête du Taureau, où elle se perdait insensiblement. Du côté du septentrion elle comprénait les trois plus luisantes d'Aries, et du côté du midi elle rasait Menkar et les étoiles de l'épaule du Taureau."


N. 345

No. 344.

CASSINI'S OBSERVATION.

APRIL 21st, 1685 : Evening.

Lat. 48° 51′ N.: Lon. 2° 22′ W.
Observation at 9 o'clock.

(Compare mine of April 21st, 1854, No. 141; and notice particularly the coincidence in the unusual positions of the Zodiacal Light, as regards the ecliptic.)

"Le 21 d'Avril [1685], à 9 heures du soir, le ciel étant fort serein, la clarté comprénait du côté de septentrion, le pied et la jambe australe de Persée, et le pied boréal avec le genou austral d'Auriga. Elle traversait la Voye de Lait, et allait finir à l'étoile dans l'épaule du précédent des Jumeaux, laquelle fait un triangle équilatéral avec les deux têtes. Sa partie méridionale comprénait l'œil boréal du Taureau, et laissait à côté l'œil austral. Son extrémité méridionale passait entre les deux cornes du Taureau, laissant la corne australe du côté du midi. Elle déclinait donc évidemment de l'écliptique vers le septentrion, comme elle avait fait vers la fin d'Avril de l'année 1683, qui est la circonstance principale qui me fit penser à l'hypothèse de la situation de cette lumière selon un plan qui convienne à peu près avec celui de l'équateur du soleil." [P. 162.]

No. 345.

CASSINI'S OBSERVATION.

SEPTEMBER 9th, 1685: Morning.

Lat. 48° 51′ N.: Lon. 2° 22′ W.
Sun rose at 5*h.* 33*m.* Observation at 3*h.* 15*m.*

(Compare mine of September 20th, 1854, No. 217.)

"Le 9 de Septembre, 1685, à 3 heures et un quart du matin, la lumière paraîssait du côté d'orient beaucoup plus claire que la Voye de Lait, avec laquelle elle se confondait à son extrémité. Elle passait sous la tête des Jumeaux, qu'elle laissait au nord, et couvrait toute l'Ecrevisse. À 3 heures et 3 quarts elle enfermait la tête et le col du Lion avec la tête de l'Hydre. Le cœur du Lion était au milieu de sa largeur. Selon cette observation, la largeur de la lumière était de 27 ou 28 dégrés, et elle était aussi partagée à peu près également par l'écliptique. Sa longueur entre le soleil et la Voye de Lait était de 79 dégrés. À 4 heures le crépuscule paraîssait comme une bande lumineuse de la largeur d'environ 10 dégrés, qui n'effaçait pas néanmoins la lumière extraordinaire, ni la Voye de Lait, en sorte que l'on voyait la lumière faire un angle avec le crepuscule d'un côté, et avec la Voye de Lait de l'autre."

Milky Way
Milky Way
Milky Way
Milky Way
Hor. Circ.

No. 346.

CASSINI'S OBSERVATION

SEPTEMBER 27th, 1685. MORNING.

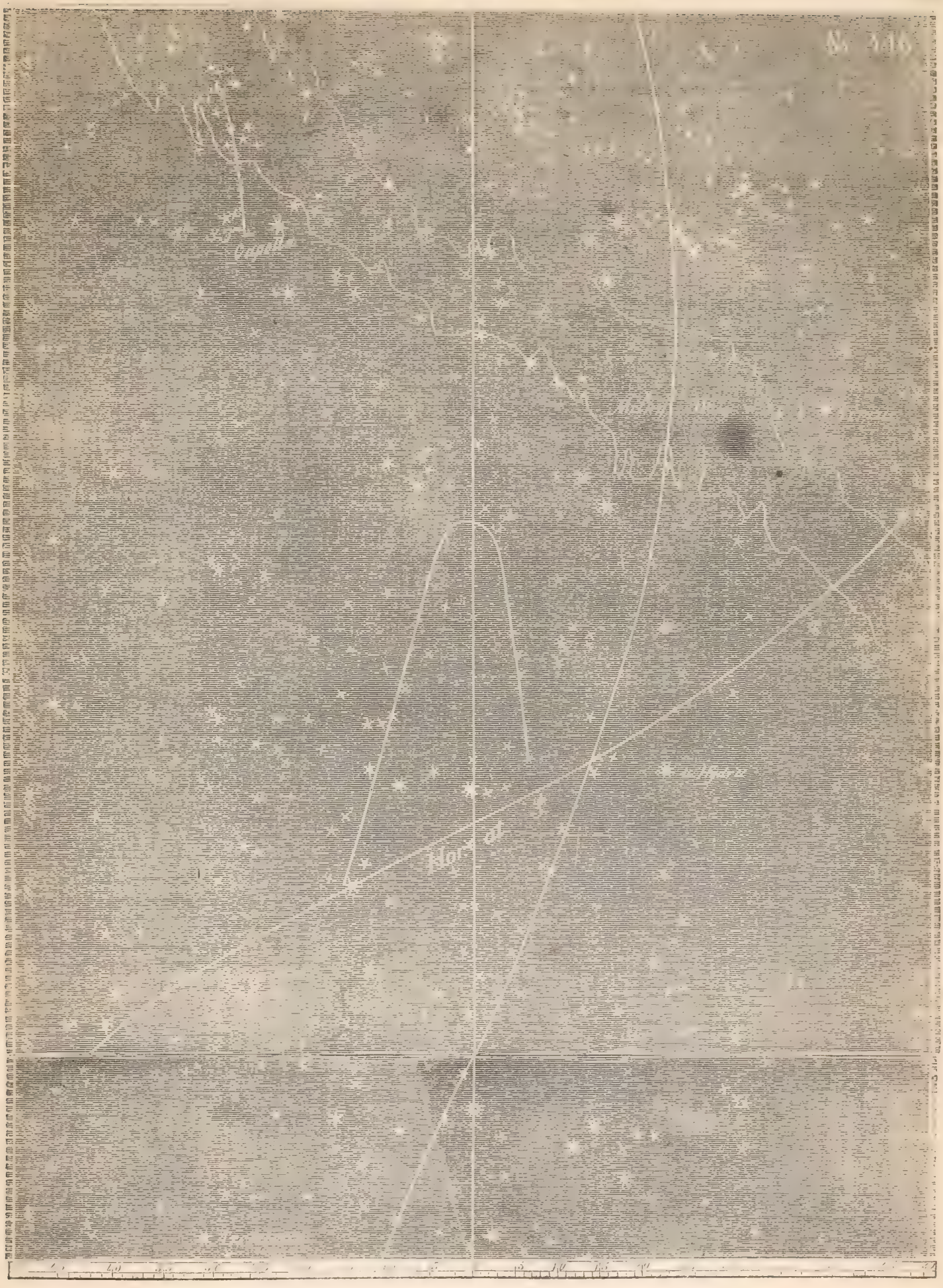
Lat. 48° 51′ N.: Lon. 2° 22′ W.
Sun rose 5*h.* 5*m*

(Compare mine of September 27th, 1854, No. 221.)

"Septembre 27, 1685.—À 3 heures du matin je vis la lumière sur le signe du Lion et de l'Ecrevisse, où elle se terminait du côté d'occident, se perdant dans cette constellation si insensiblement qu'on avait quelques fois de la peine à l'appercevoir. Les pieds du Lion étaient à son terme méridional: le dos et la queue du Lion à son terme septentrional. Il est donc évident que l'écliptique ne divisait pas également la largeur de la lumière, mais que sa plus grande partie restait du côté du septentrion, puisque le cœur du Lion, qui a un peu de latitude septentrionale, était plus près du terme méridional que du septentrional. Sa longueur jusqu'au soleil était de 70 dégrés. À 4 heures 35 minutes le crepuscule commençait à paraître, et la lumière extraordinaire* paraissait encore depuis la ceinture de la Vierge jusqu'à l'Ecrevisse, que était entièrement dans la lumière. La partie septentrionale de la tête et du col du Lion était dehors du côté du septentrion; et la tête de l'Hydre était dehors du côté du midi: ainsi sa largeur en cet endroit était de 22 dégrés." [P. 173.]

[I have not attempted to draw boundary-lines according to this last annotation (at 4*h* 35*m*), as I cannot understand it clearly.]

* In these annotations, Cassini often calls the Zodiacal Light "*la lumière extraordinaire.*"


Capella
Aldebaran
Rigel
Sirius
Procyon
Pollux
Regulus
Spica
Arcturus
Antares
Vega
Altair
Fomalhaut
Deneb
Markab
Algenib
Alpheratz
Mirach
Almach
Hamal
Menkar
Algol
Alcyone
Atlas
Electra
Maia
Merope
Taygeta
Pleiades
Hyades
Praesepe
Orion
Gemini
Cancer
Leo
Virgo
Libra
Scorpio
Ophiuchus
Hercules
Lyra
Cygnus
Aquila
Sagittarius
Capricornus
Aquarius
Pisces
Andromeda
Pegasus
Perseus
Auriga
Taurus
Aries
Cassiopeia
Cepheus
Draco
Ursa Major
Ursa Minor
Bootes
Corona
Serpens
Ophiuchus
Scorpio
Sagittarius
Capricornus
Aquarius
Pisces
Cetus
Eridanus
Orion
Lepus
Monoceros
Canis Major
Canis Minor
Hydra
Crater
Corvus
Centaurus
Lupus
Ara
Corona Australis
Piscis Australis
Grus
Phoenicopterus
Sculptor
Fornax
Cetus
Eridanus
Lepus
Columba
Puppis
Argo

No. 347.

CASSINI'S OBSERVATION.

NOVEMBER 27th, 1685: MORNING.

Lat. 48° 51′ N.: Lon. 2- 22′ W.
Sun rose at 7*h*. 33*m*.

(Compare mine of November 27th, 1854, No. 246.)

"Le 27 Novembre [1685], à 5 heures du matin, la lumière se voyait étendre sur la constellation de la Vierge: elle passait entre la méridionale de la ceinture et la moyenne des trois dans la même ceinture, laissant au septentrion toute l'aile septentrionale. L'épi de la Vierge la bordait du côté méridional, et vers l'horison elle s'élargissait jusqu'au pied septentrional: du côté d'occident elle s'étendait près de Saturne, qui était au 29 dégrés de la Vierge, à la distance de 67 dégrés du soleil.

À 5 heures 25 minutes Jupiter parut sur l'horison et semblait être au bord méridional de la lumière, quoiqu'il eût un peu de latitude septentrionale; et du côté du septentrion elle approchait des étoiles qui sont dans le col du serpent d'Ophiuchus. D'où il paraît que la lumière était presque toute du côté du septentrion, à l'égard de l'écliptique, et qu'elle était beaucoup étroit qu'au mois précédent, sa largeur dans la ceinture de la Vierge n'étant que de 5 dégrés."

[I had drawn the southern boundary according to his description, but, by some inadvertency, it has not been inserted in the chart here given. The reader will perceive that it appeared to Cassini to be a few degrees north of the ecliptic.

No. 347
Arcturus
Hor
Milky Way

No. 348.

CASSINI'S OBSERVATION.

DECEMBER 4th, 1685: MORNING.

Lat. 48° 51′ N.: Lon. 2° 22′ W

Sun rose at $7^h.\ 43^m$.

(Compare mine of December 18th, 1854, No. 257.)

"Le 4 Décembre [1685], à 5 heures 15 minutes du matin, la lumière s'étendait sur la partie inférieure de la Vierge, et se terminait insensiblement près de la ceinture à 68 dégrés de distance du soleil. Elle comprénait les autres étoiles de la Vierge au-dessous de la ceinture jusqu'aux pieds, et celles que l'on voyait de la Balance, et s'approchait de celles du ventre du serpent d'Ophiuchus. L'epi de la Vierge en était un peu éloigné du côté du midi; sa largeur sur la Balance était de 15 dégrés. Jupiter, qui était à 11 dégrés du Scorpion, était compris dans la clarté, et y faisait comme une brèche: d'où il paraît que la lumière était presque toute du côté du septentrion à l'égard de l'écliptique." [P. 175.]

N. 340

No. 349.

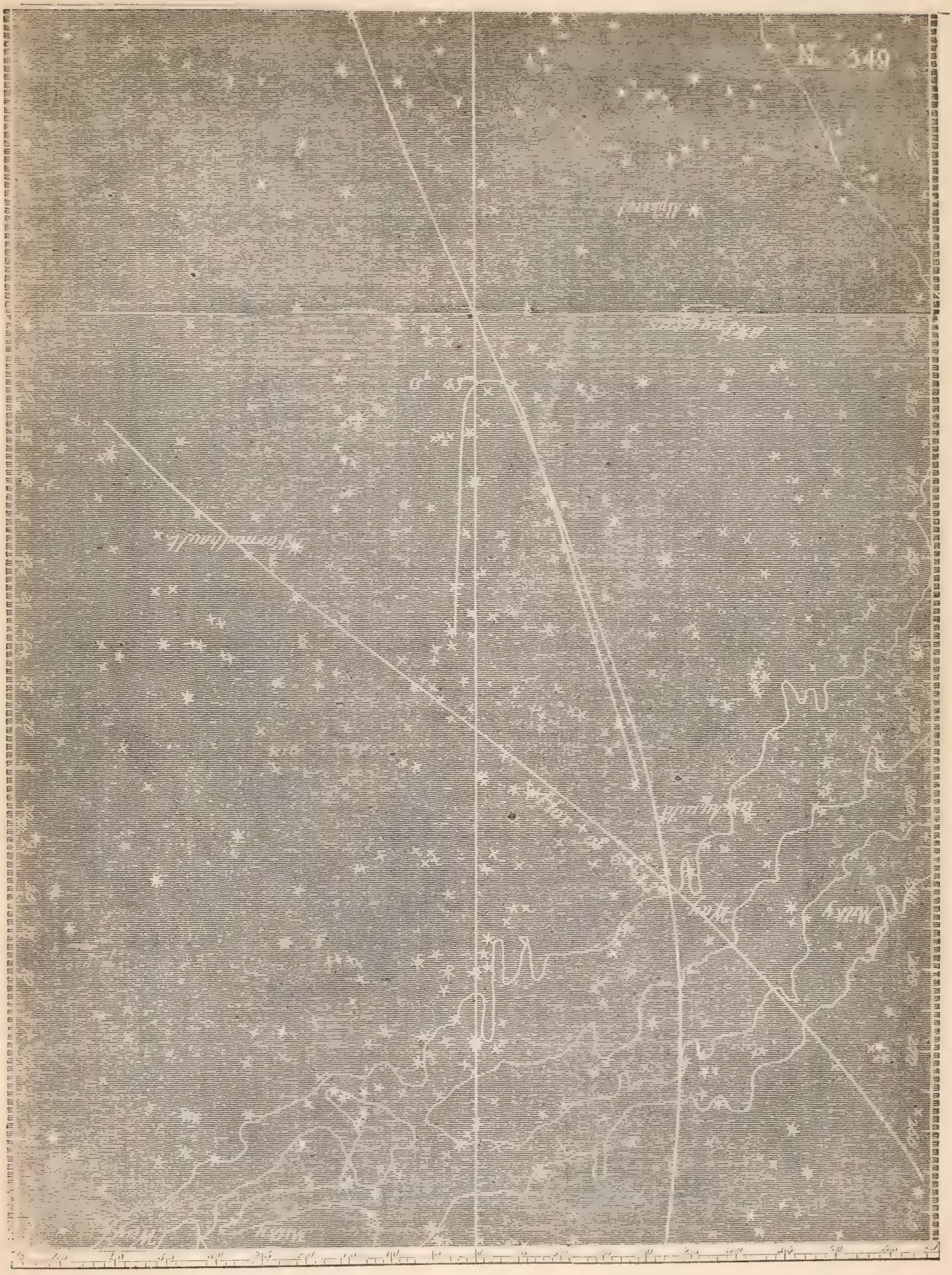
CASSINI'S OBSERVATION.

DECEMBER 25th, 1685: Evening.

Lat. 48° 51′ N.: Lon. 2° 22′ W.
Sun set 4*h*. 3*m*.

(Compare mine of December 20th, 1854, No. 262.)

"Le 25 Décembre [1685], au soir, après le passage de l'étoile polaire par le méridien [say at 6ʰ 43ᵐ], nous observâmes cette lumière à l'occident. Elle semblait se séparer de la Voye de Lait dans la constellation d'Antinöus; son terme boréal passait par la main d'Antinöus, par les épaules et par le coude oriental d'Aquarius, et semblait arriver jusqu'aux étoiles méridionales du Poisson Austral, qui sont près de l'écliptique. Ainsi son terme oriental était distant du soleil de 76 dégrés. Du côté du midi elle comprénait Venus, qui était à 18 dégrés du Capricorne, avec un dégré et demi de latitude australe; et elle s'étendait un dégré de plus vers le midi. Elle comprénait aussi Mars, qui était à 7 dégrés et demi des Poissons, avec un peu moins d'un dégré de latitude australe; la plupart de la lumière était donc encore du côté du septentrion à l'égard de l'écliptique; sa largeur sur la constellation d'Aquarius était de 12 dégrés; mais elle était plus grande vers Antinöus." [P. 176.]


N. 349

No. 350.

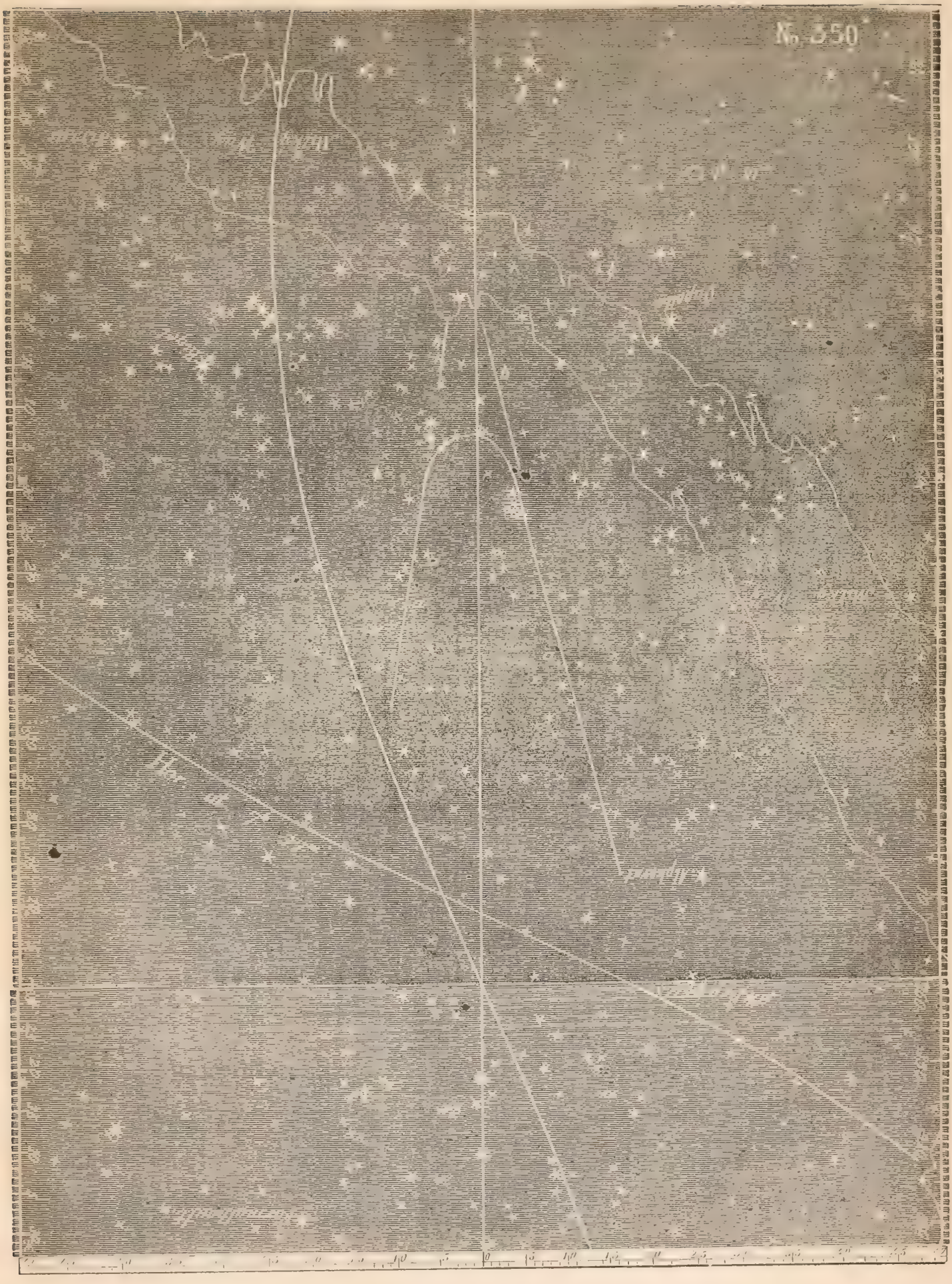
CASSINI'S OBSERVATION.

MARCH 7th, 1687: Evening.

Lat. 48° 51′ N.: Lon. 2° 22′ W.
Sun set 5*h*. 47*m*.

(Compare mine of February 25th, 1854, No. 124.)

"Le 7 Mars, [1687], après le passage du Grand Chien par le méridien [say at $7^h\ 27^m$], on voyait la lumière étendue sur la queue du Poisson Austral, sur le lien des Poissons, sur la tête de la Baleine, et sur la constellation d'Aries, dont les cornes étaient à son extrémité boréale, et l'étoile qui est sous l'œil de la Baleine à son extrémité australe [see *a a* in chart]. Elle passait par les Pleiades, et se terminait insensiblement aux étoiles qui sont dans le col du Taureau, et un peu après elle semblait s'étendre jusqu'à la Voye de Lait [see *b b* in chart]. Dans cette dernière observation, sa longueur depuis le soleil était de 90 dégrés, et sa largeur sur la constellation d'Aries et de la Baleine de 19 à 20 dégrés."


No. 350

No. 351.

CASSINI'S OBSERVATION.

OCTOBER 15th, 1687: Morning.

Lat. 48° 51′ N.: Lon. 2° 22′ W.
Sun rose 6*h.* 25*m.*

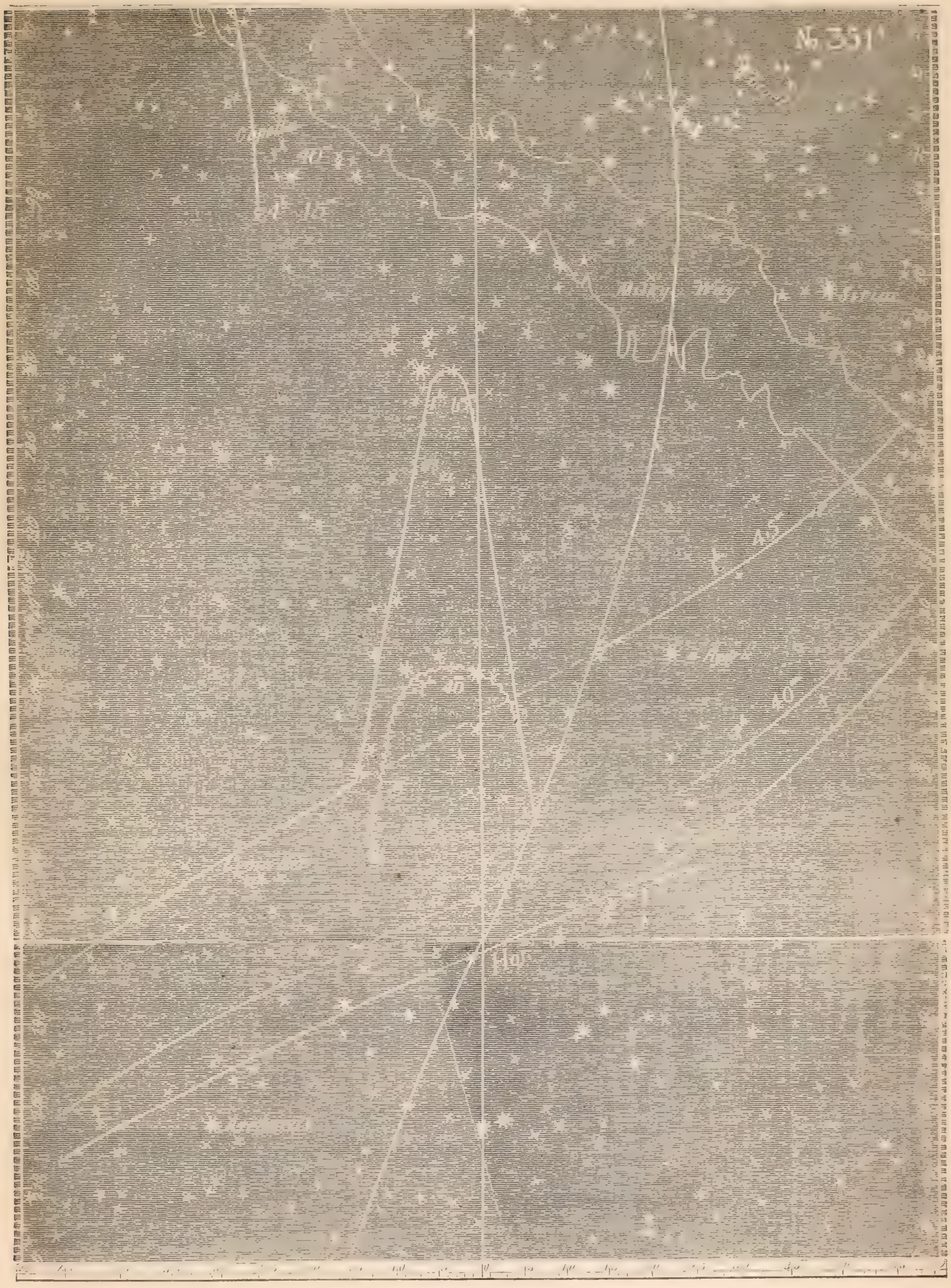
(Compare mine of October 16th and 20th, 1854, Nos. 228 and 232.)

"Le 15 Octobre, 1687, à une heure et trois quarts du matin, à l'observatoire, la lumière se voyait faiblement sur le col du Lion et sur l'Ecrevisse, dont les étoiles les plus luisantes paraîssaient à son terme méridional, et elle semblait s'étendre presque jusqu'à la tête méridionale des Jumeaux. La partie plus évidente se terminait à un dégré et demi de l'Ecrevisse [at *a* on chart]. À 2 heures le cœur du Lion paraîssait à un tiers de la largeur de la lumière, qui s'étendait jusqu'à l'étoile la plus claire du col.

"À 3 heures 40 minutes la lumière était fort claire* au-dessous du cœur du Lion, jusqu'à un dégré de hauteur sur l'horison. Elle paraîssait un peu concave du côté du midi, et plus convex du côté du septentrion.

"À 4 heures et un quart le terme austral de la lumière était presque perpendiculaire à l'horison, et le boréal était incliné vers le midi." [Pp. 201, 202.]

* On 8th October of this year, he also says: "A 4 heures et demi, la clarté au-dessous du cœur du Lion était très grande, et la largeur de cette grande clarté était de 12 dégrés" [the whole width of the Light being 14 degrees]. On the 10th of same month he has a similar record. This, no doubt, was what I have called in my records *effulgent light*, and which I have bounded with zigzag lines.


No 351
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No. 352.

CASSINI'S OBSERVATION.

NOVEMBER 14th, 1687: Morning.

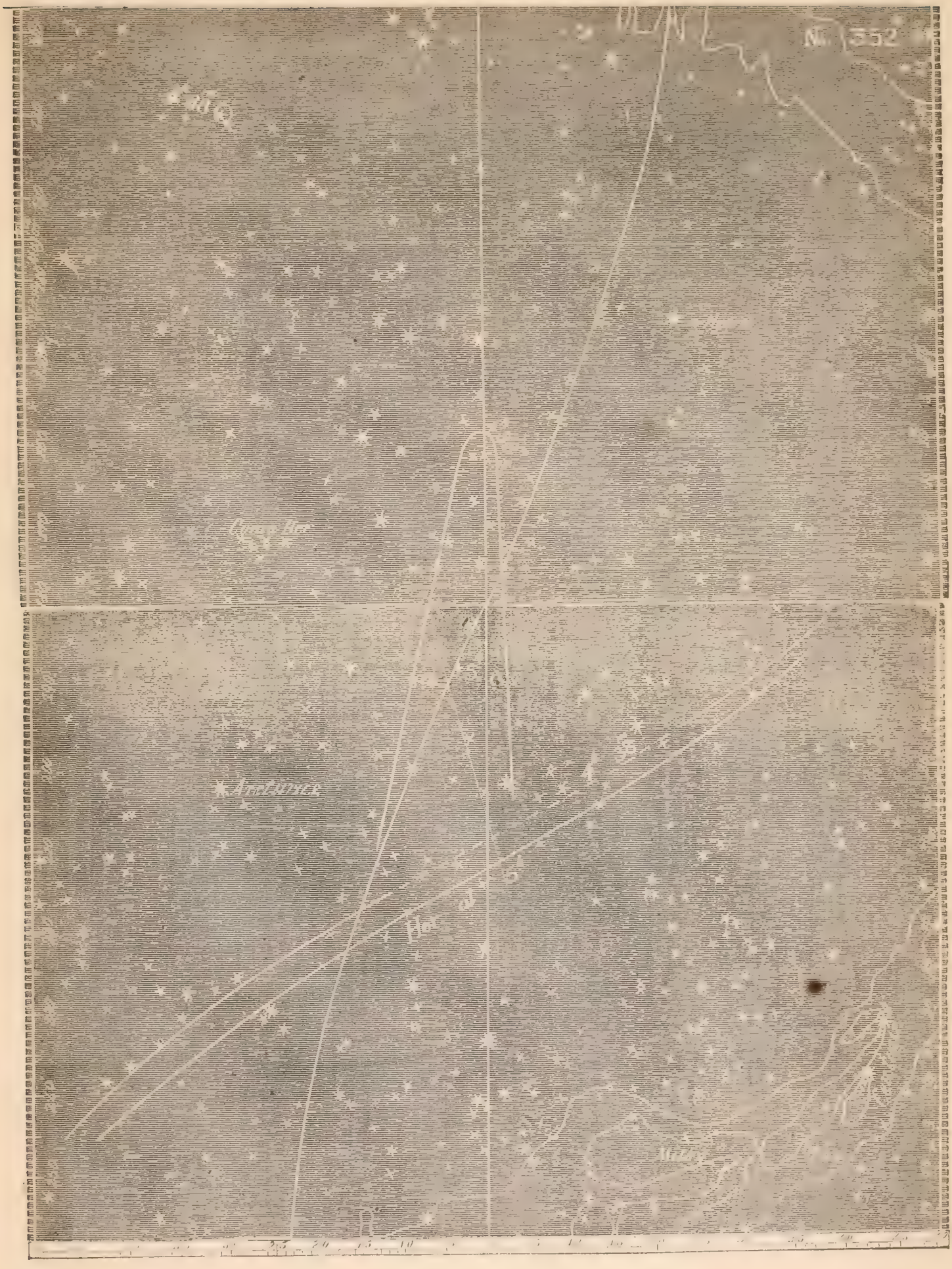
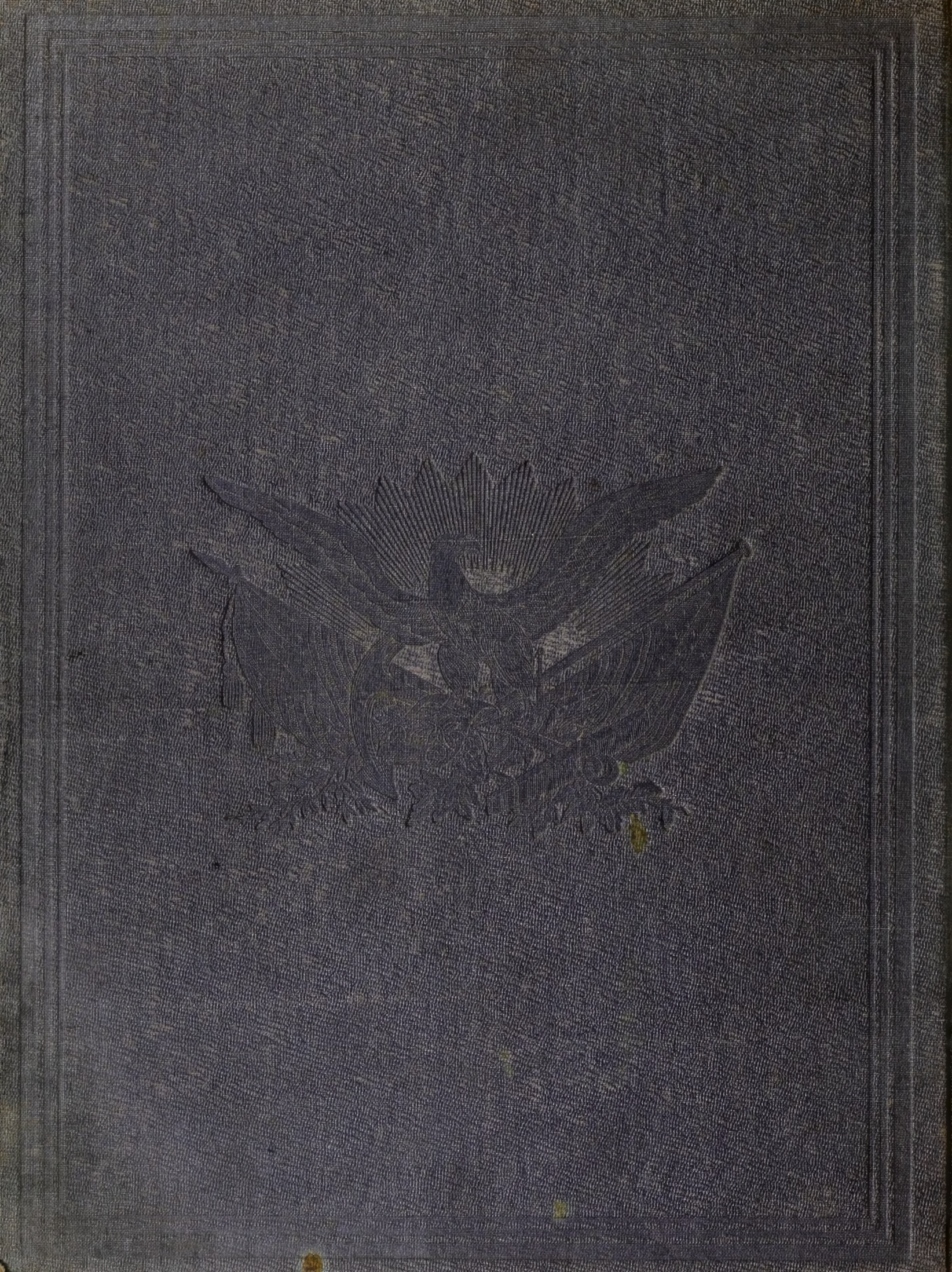
Lat. 48° 51′ N.: Lon. 2° 22′ W.
Sun rose 7*h*. 14*m*.

(Compare mine of November 20th, 1854, No. 241.)

"Le 14 Novembre [1687], à 4 heures et $\frac{1}{4}$, on voyait la lumière sur la partie de la constellation de la Vierge qui était sur l'horison; elle se terminait à la jambe occidentale du Lion près de l'écliptique, ou un peu plus loin vers le ventre. La septentrionale de deux étoiles claires dans la ceinture de la Vierge était au côté septentrional; la méridionale était presque dans le milieu de sa largeur, ou un peu plus près du côté méridional. Proche l'horison la lumière s'étendait du côté du septentrion jusqu'au genouil septentrional de la Vierge.

"À 4 heures 38 minutes Saturne parut près du milieu de la lumière, et un peu après l'epi de la Vierge s'étant lévé parut plus vers le septentrion.

"À 5 heures la partie de la lumière qui comprénait Saturne et l'epi de la Vierge était beaucoup plus claire que la Voye de Lait; cette plus grande clarté n'arrivait qu'à l'étoile méridionale de la ceinture de la Vierge [see *a a* in chart]. À 5 heures 48 minutes l'aurore commençant à paraître, effaça peu-à-peu la lumière." [Pp. 202, 203.]


No. 352
Cassiopeia
Andromeda